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(English Edition)

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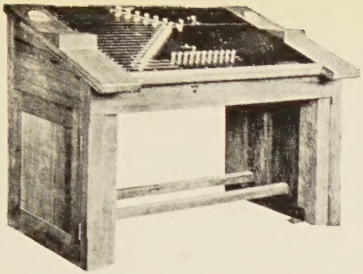

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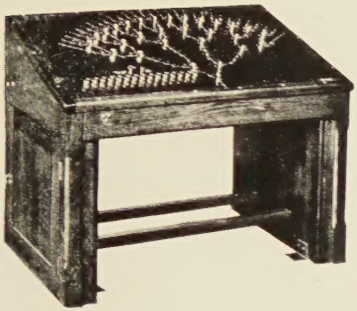

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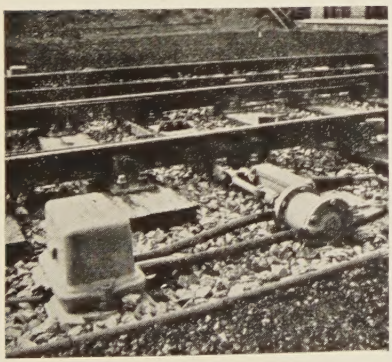

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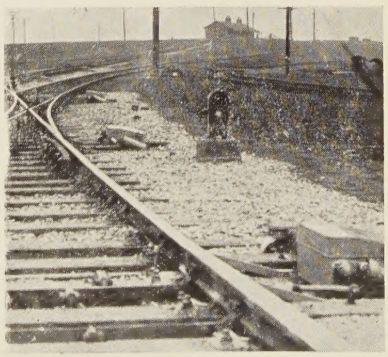

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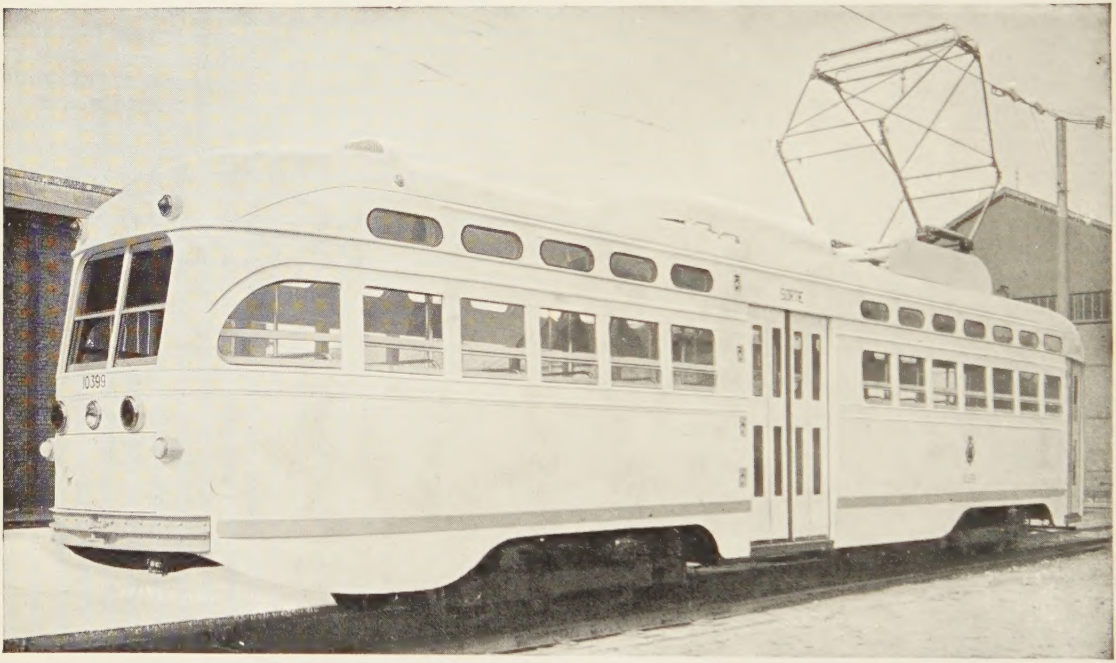

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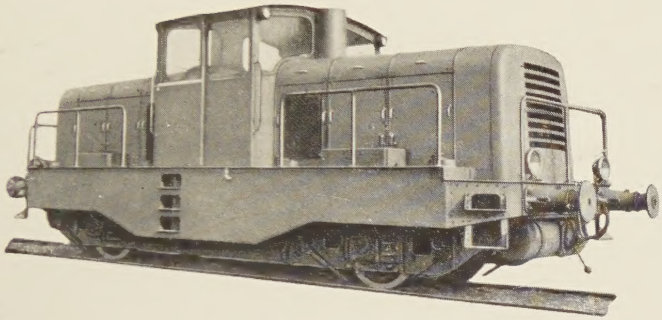

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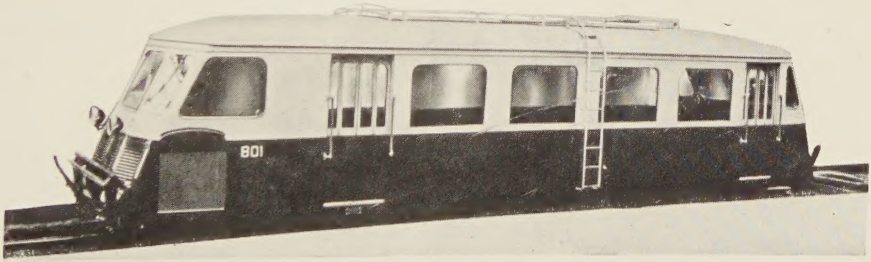

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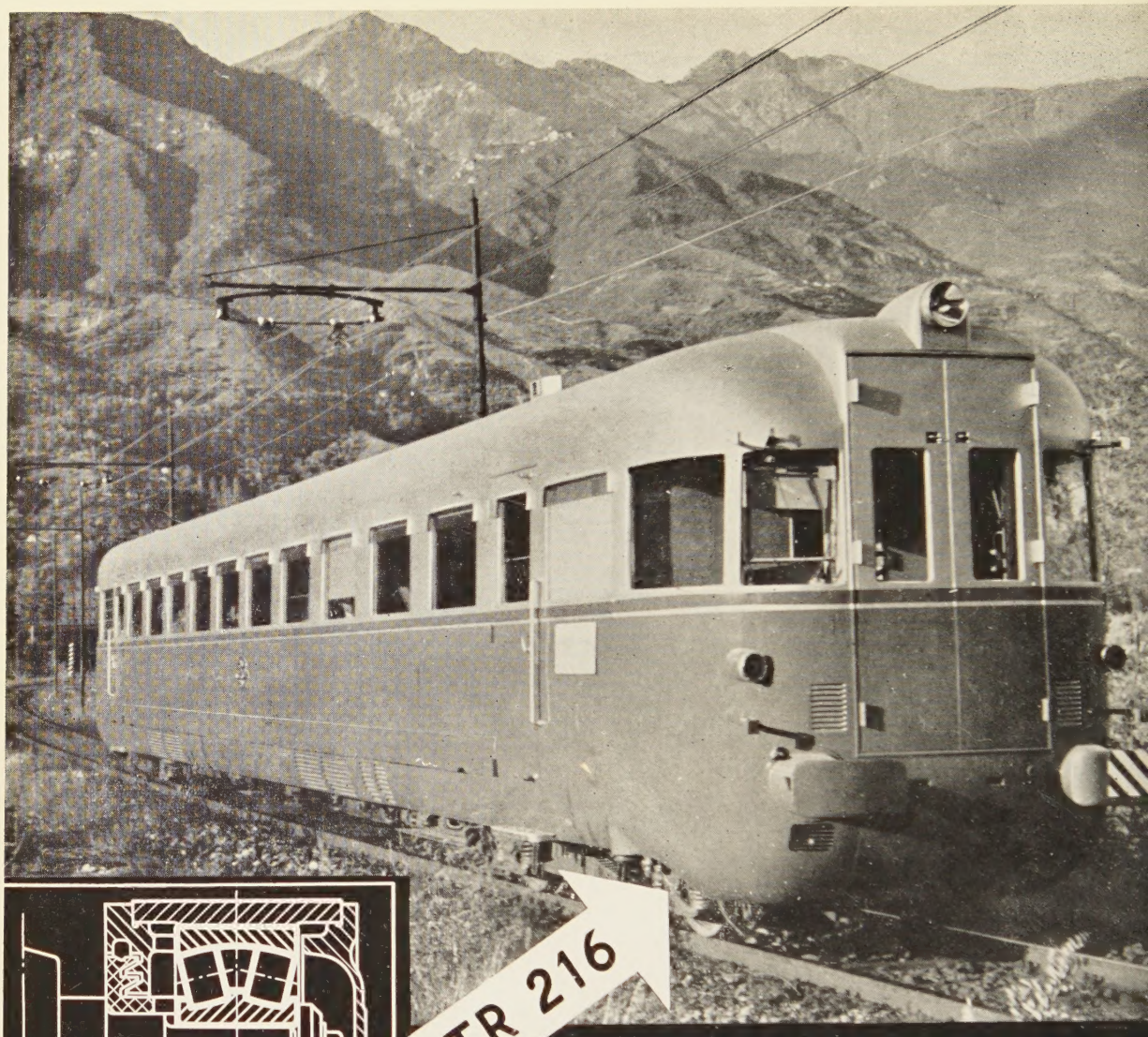

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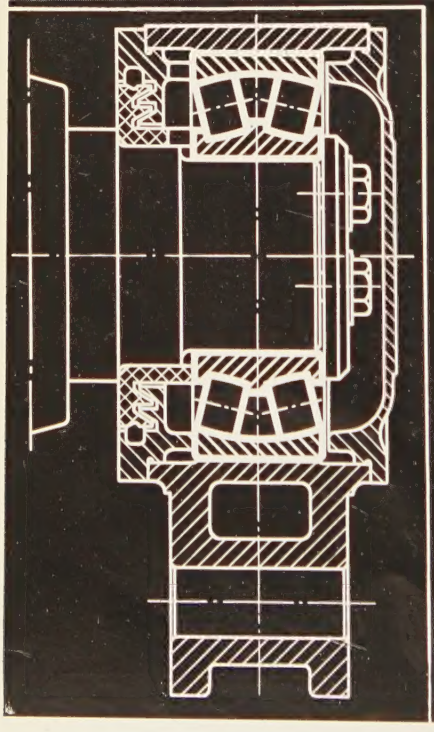

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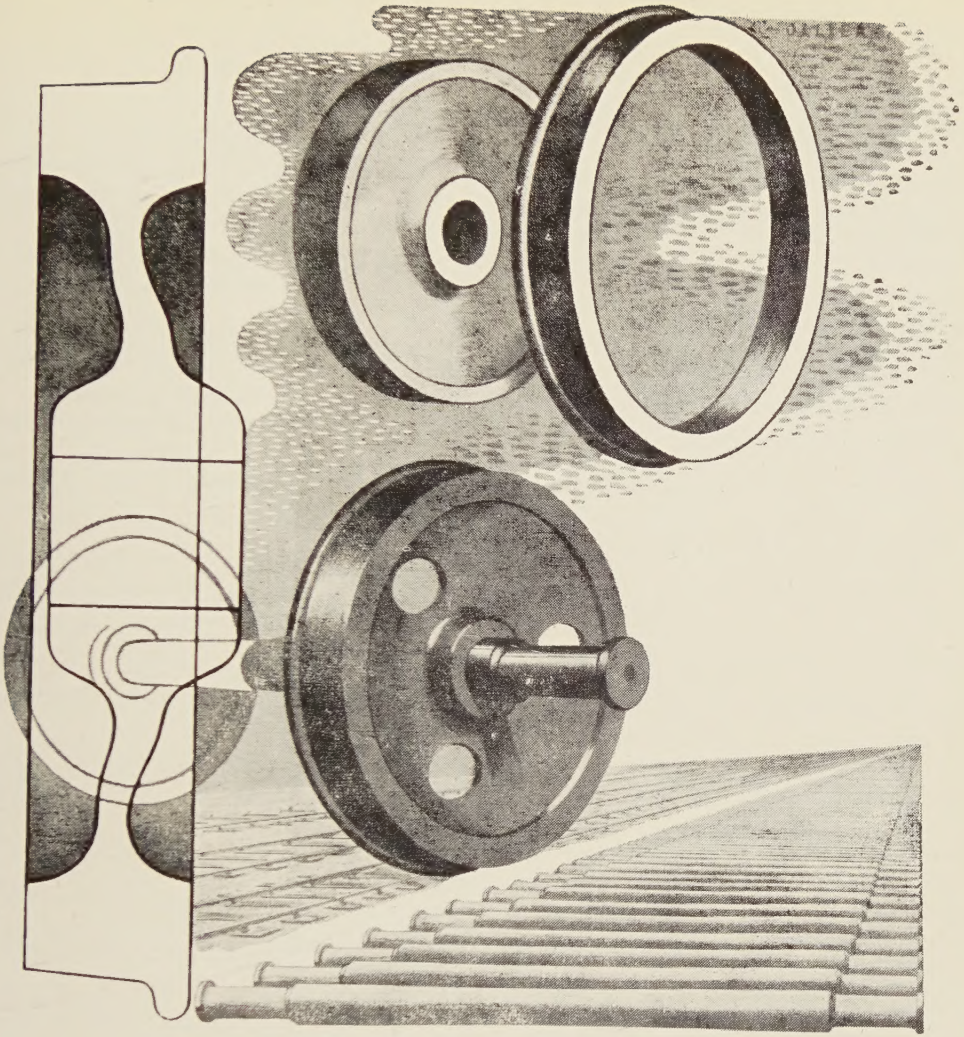

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OF THE

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BULLETIN
OF THE
INTERNATIONAL RAILWAY CONGRESS
ASSOCIATION
(ENGLISH EDITION)

[656 .225 & 656 .261]

INTERNATIONAL RAILWAY CONGRESS ASSOCIATION

ENLARGED MEETING OF THE PERMANENT COMMISSION
(STOCKHOLM, 1952.)

QUESTION II.

What are the quickest and most economical means to carry out door to door service for railway transports?

What are the best conditions of use of containers for small miscellaneous traffic (dimensions of the containers, conditions of ownership, tariffs)?

What are the packing types to be recommended?

REPORT

America (North and South), Australia (Commonwealth of), Burma, Ceylon, China, Egypt, India, Irak, Iran, Irish Free Stat New Zealand, Pakistan, South Africa, Sudan, United Kingdom of Great Britain and Northern Ireland and the territories for whose international relations the United Kingdom is responsible),

by M. G. DE BRUIN,
General Manager N. V. Van Gend & Loos, (Netherlands).

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Introduction.

1. As a reporter for the countries mentioned above, Dr. F. GERST of the Netherlands Railways was originally appointed. He has not been able to acquit himself of his task, because he took up an other sphere of activity outside the Railways on October 1st, 1951. The undersigned has been appointed in his place.

The reporter wishes to express his

acknowledgments for the preparations made by Mr. GERST and Mr. SAUVAGEAT of the Swiss Federal Railways, in consultation with the *General Secretary*, in drawing up the Detailed List of Questions. Also, he wishes to acknowledge with thanks the help he has derived from the information drawn up in several answers to the questionaire.

2. The list of questions was sent to 22 Administrations. A reply was received from :

British Railways (*);
London Transport Executive;
Burma Railways;
Malayan Railway;
Ceylon Government Railway (*);
East African Railways;
Eireann Railways (*);
Egyptian State Railways (*);
India Railway Board (*);
Iraqi State Railways;
New Zealand Government Railways (*);
Nigerian Railway;
Rhodesia Railways (*);
South African Railways (*);
Sudan Railways.

Of the Administrations mentioned above, those marked with (*) have supplied information on the subject, while the others stated in their reply that no information could be given.

CHAPTER I.

RESULTS OF THE LIST OF QUESTIONS.

PART I.

What are the quickest and most economical means to carry out door to door service for railway transports?

The list of questions distinguishes between full loads and part loads (parcels traffic). With the latter, supplementary consideration is given to the small containers in a special chapter (see Part II). In the following outline, this division is also observed.

A. *Full loads.*

The list of questions asks data about the different means (belonging to the Administrations as well as to the other undertakings), to assure the door to door goods service, under the following headings :

1. Sidings, including clients' warehouses at stations and port installations;

2. Transport of complete wagons by road;

3. Transport of the body of the wagon by road as a whole or divided up into units (for example containers);

4. Transport of road trailers on wagons (rail/road trailer system);

5. Transhipment of goods by technical means or by hand from the wagon to the road vehicle and vice versa.

1. — Sidings, including clients' warehouses at stations and port installations.

— What percentage of the total tonnage is transported :

a) *between private sidings including clients' warehouses at stations and port installations;*

b) *from stations to sidings including clients' warehouses at stations and port installations and vice versa ?*

— In order to improve the door to door service do you think it would be advisable for the railway to encourage to a greater extent the development of private sidings, including clients' warehouses at stations and in what way (for example taking over a larger proportion of the capital costs, special rates, etc....) ?

All the railways questioned offer siding-service, both to the sheds and to the clients' premises in the goods-yards and to premises situated elsewhere. The port installations also receive siding-service. In the case of traffic passing between traders whose premises are rail-connected at both ends, as the *British Railways* state, railway owned containers may be used at the request of a trader, where cartage is required at either forwarding or destination

point; privately owned containers, of approved dimensions, are conveyed without restriction.

Only, the *Eireann Railways* have been able to give information about the extent of the transport via sidings : 7 1/2 % of the transport makes use of a siding both on departure and on arrival, and 33 1/3 % either on departure or on arrival.

The general opinion among Administrations is that, provided a sufficient amount of traffic is available, every encouragement should be given to traders to develop terminal facilities, either on railway premises or connected thereto by siding, as this tends to tie traffic to the rail. Opinions differ as to *how* such encouragement should be given.

The cost of sidings consist of : capital cost, maintenance cost and cost of operation. Though this is not said explicitly in all the replies, it may be assumed that, as a rule, the Administrations charge the capital cost of the private sidings to the client's account. Only the *Eireann Railways* undertake all or portion of the cost of the siding installation, dependent on a guaranteed traffic, or refund initial cost undertaken by trader, in whole or part by freight rebate. On the contrary *Indian, New Zealand* and *South African Railways* have no intention to employ these means to encourage siding development. The *New Zealand Government Railways* consider that such action would lead to difficulties and anomalies in dealing with other than private siding traffic. No information has been received about maintenance and working cost. Only, the *South African Railways* state that private sidings are maintained by the Administration at the expense of the firm served; private siding charges are levied in addition to the normal railage.

Other means of encouragement mentioned are : the letting out of sites and premises in railway yards on attractive conditions. The following methods are adopted by the *British Railways* :

a) the letting to traders of covered or uncovered accommodation within railway goods depots. Favourable rentals are negotiated on the basis that the traffic is tied to the railways by a suitable traffic clause;

b) in certain cases traders have been encouraged to develop their own facilities on railway property let under a long lease;

c) where the operation of a private siding, installed at trader's own cost, results in a saving to the railway of station terminal cost, this may be reflected in the rates granted or by a special private siding allowance;

d) during recent years, the principle of « Railhead Distribution » has developed considerably. Under this scheme, traders are encouraged to concentrate traffic for specified areas on selected « railheads », where railway warehouse accommodation is let to them. They are thereby enabled to load in bulk directly to a given point, where the direct load is broken down, for distribution over an adjacent area, thus reducing transit times and avoiding transhipments, while the trader also benefits from a cheaper bulk rate. The handling into and out of store and other ancillary services may be performed either by railways' or by traders' own staff installed for the purpose.

2. — *Transport of complete wagons by road.*

This type of equipment is not in use with any of the Railways covered by this report.

3. — *Transport of the body of the wagon by road as a whole or divided up into units (for example containers).*

— What technical means do you use to assure this transport (for each main category of goods) ?

— Give a description of these technical means, appending, if possible, photographs and sketches in sufficient detail to give a clear idea of the means used.

— What handling is necessary for the terminal transport ? How many men are

required to carry out each of these operations? How long do they take? What was the cost of purchase in 1951, of the means used (road transporters, containers, specially designed wagons, trailers, cranes, special gear, etc.)? What is the average life of these means? What sinking fund rates are used? How much fuel or electricity and lubricating oil are used for transhipment operations on the one hand and transport on the other? Can you give any figures for maintenance and repair (per year and per kilometre for the means of transport and per hour of use for the transhipment gear)? What is the average speed from one end of the journey to the other (i.e. from the stations to the clients' premises and vice versa) with these means of transport?

Containers are in use only with *British, Egyptian, Eireann* and *New Zealand Railways*. Data available have been summarised in *Appendix I.*

New Zealand Railways only provide containers for the purpose of packing household furniture and effects, conveyed under the « house-to-house » removal system, at an extra charge (hiring fee) of £ 1.0.0 to £ 2.0.0.

For the purpose of easing the adverse effect of competition, the *Egyptian State Railways* have introduced box-containers, also for household removals from door to door. The turnround of these containers is 48 hours (2 hours being allowed for each loading and unloading operation); the average distance travelled loaded is 220 km (140 miles); 30 % empty runnings. Special flat rates are charged, tare weight not being taken into account; the minimum chargeable per container is 2 tons. These containers are sometimes used to group parcels traffic from station to station and for other station-to-station traffic to reduce empty runnings to a minimum.

The *Eireann Railways* use various types of open and covered containers and tanks for milk. The average turnround is 4 days : containers given to firms to load or unload, are usually returned on the same day; the average distance travelled loaded is 80 miles; 50 % empty runnings for open and 33 1/3 % for covered containers. Nett weight is charged subject to appropriate minima and charges are calculated at the appropriate class rates, subject to differential. Containers are used, to a limited extent, to group consignments of parcels traffic from one station to another.

The extensive container service of *British Railways* is well-known. There are 4 main types of containers (types A, B, C and D, see *appendix I* and figures 1, 2, 3 and 4), but special types have been evolved to meet specific requirements (for examples see *appendix I* and figures 5, 6 and 7). Normal carriage charges applicable to the traffic concerned, plus a differential charge, are raised only upon the weight of contents; minimum 1 ton per container (2 tons for large containers to and from Northern Ireland and the Republic of Eire). The container system is generally applicable to loads passing from one consignor to one consignee, but, except for traffic to Eire, multiple collections or deliveries from or to a number of addresses in the same town can be undertaken by arrangement. Containers can also be used by prior arrangement for traffic passing by certain routes to and from the Continent, the Channel Islands, Scottish Isles, Isle of Man and Isle of Wight. Figure 16 shows the transport of goods from door to door in railway containers, involving short sea journeys.

In addition to the containers in general use, insulated and ventilated containers are available for the conveyance of perishable commodities (chilled and fresh meat, deep frozen foods, ice-cream, etc.). A cradle specially designed for the conveyance of sheet glass and a bottom discharge container are of a more novel character (see figures 8 and 9 and *appendix I*). The bottom discharge container is used for such traffic as limestone, cement, dolomite, etc. and can be discharged by means of cranage to adjacent road vehicle or to silo (warehouse).

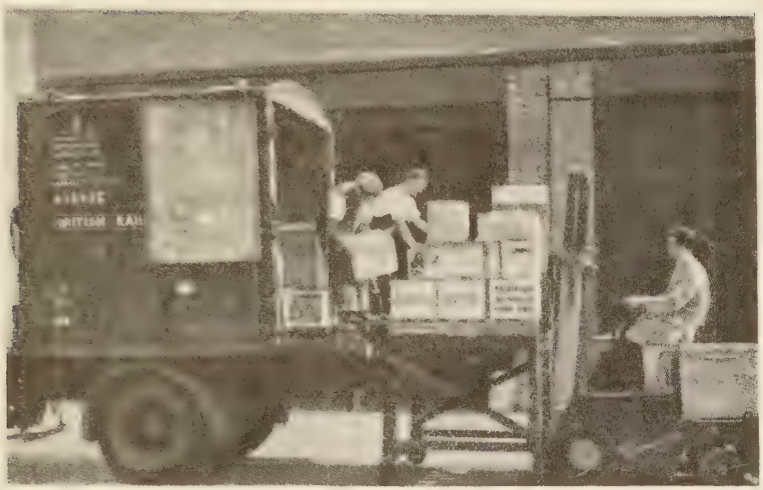


Fig. 1. — *British Railways.* Small covered container (type A).

Fig. 2. — *British Railways.* Large covered container (type B).

To cater for the increasing demands for transport of liquids in bulk, *British Railways* undertake to construct tank equipment to the specific requirements of individual traders and to hire such equipment to them, under agreement, at annual rental charges. Special linings, e. g. stainless steel, vitreous enamel, etc., can be incorporated in the tanks, as well as effective insulation; provision can be made for heating during transit and pumps can be fitted to facilitate discharge of contents. The rail chassis are

CON

Type of container	Figure	Designed for	Construction
			BRIT
Main types :			
Covered small A	1	Confectionnery, groceries, boots and shoes, wireless apparatus, textiles, etc.	End doors; non-wheeled
Covered large B	2	Earthenware, tinware, enamelled ware, electrical equipment, etc., and for larger consignments of a similar variety of goods to those carried in the A type	Side doors and one end door; non-wheeled
Open small C	3	Stoves, grates, ranges, heaters and small types of machinery, etc.	End doors; non-wheeled
Open large D	4	Machinery, glazed ware, stoneware, castings, baths, asbestos sheets, slates, tiles, accumulators, motor engines, etc., and similar classes of goods to those carried in the C type	Side doors and one end door; non-wheeled
Special types :			
Covered small AF	(*)	Commodities to be conveyed at very low temperatures, *e. g.* ice-cream, quick frozen foods and frozen pancreas glands	One end door on « floating » hin highly insulated; non-wheeled; ins lining plywood with galvanised s face, outside panels plywood
Covered large BC	5	Bicycles	Fitted with racks to separate the chines in transit; non-wheeled
Covered large BK . . .	6	For household removals and new furniture	End doors; interior slats to facili securing of furniture; in cert cases specially fitted internally carry cloth in one direction garments on clothes hangers on return journey; non-wheeled
Covered large BM . . .	(*)	Fresh killed meat	End door and side doors both sic fitted with bars carrying appr 70 hooks; ventilated; non-whee

(*) See : *Bulletin*, May 1950, A.A. Harrison, Report 15th Session, Rome 1950.

S

APPENDIX I.

Interior dimensions			Capacity		Tare	Cost of construction in 1951	Maintenance costs per annum	Amortisation period
			Cubic feet	Tons				
LWAYS								
Length	Width	Height to centre (approximately)				£		Years
7′ 0″ to 7′ 4″	6′ 0″ to 6′ 9″	6′ 6″ to 7′ 3″	260 to 330	3	1 ton 1 cwt	96		
13′ 5″ to 15′ 10	5′ 10″ to 6′ 7	6′ 5″ to 7′ 3	500 to 733	4	1 ton 17 cwt 2 qrs	150	4 % on current replacement costs	Steel 10
6′ 11″ to 7′ 0″	5′ 11″ to 6′ 0″	3′ 0″ to 3′ 9″	126 to 157	3 and 4	12 cwt	33		Wood 15
12′ 0″ to 13′ 9″	6′ 0″ to 6′ 3″	3′ 0″ to 3′ 8″	215 to 300	4	1 t	52		
5′ 11″	5′ 5″	6′ 2″	193	3	1 ton 17 cwt 2 qrs	—	—	—
14′ 1″ to 15′ 10″	6′ 6″ to 6′ 7″	7′ 4″ to 7′ 10″	700 to 740	4	1 ton 11 cwt	—	—	—
14′ 10″ to 15′ 8″	6′ 6″ to 7′ 11″	6′ 11″ to 7′ 4″	650 to 735	4	1 ton 9 cwt	—	—	—
		Height to meat bars						
15′ 7″	6′ 6″	6′ 10″	690	4	2 tons 3 cwt	—	—	—

CONT

Type of container	Figure	Designed for	Construction
Covered large FM	(*)	Frozen meat, fish and other perishable commodities requiring maintenance of low temperature	Insulated: insulation material var from 1 $^1_2$″ to 2″ in thickness. Dry i can be used as a refrigerant and so of the containers are fitted with ro bunkers for wet ice; non-wheeled
Open small H	7	Bricks, tiles and small earthenware (can be hoisted to upper floors of buildings in construction)	Shallow, one end door; non-wheel
Bulk glass cradle	8	Sheet glass	With centre for two packs of sheets lean against; packs being held position by horizontal « gates » whi fit into slots in the base and a tightened at top corners by tensi wires; centrally pivoted adjustal battens at each end to prevent long tudinal movement of the sheets; no wheeled
(Wagon for 2 cradles)	(8)		(Shock absorbing)
Bottom discharge container .	9	Cement, limestone, alumina, dolomite, chemicals and other similar traffic in bulk (Three containers on one wagon)	Pressed steel; divided into two equ compartments which can be dischar ed either separately or simultaneous through waterproof bottom doo weatherproof hatch cover with « l and slide » arrangement to perm opening under low headroom con tions; non-wheeled
Tank	11 and 12	Liquids in bulk	Non-wheeled
(Rail chassis for tanks) . .	(11 and 12)	(One, two, three of four tanks, according to size)	
Rail/road tank trailer . .	13, 14 and 15	Liquids in bulk	
A.O. milk (*)			4 or 2 wheels
beer (*) .			
(Rail chassis for R/R tank)	(13 and 14)	(One or two of these wheeled tanks)	

(*) See : *Bulletin*, May 1950, A.A. Harrison, Report 15th Session, Rome 1950.

S *(continued)*

Interior dimensions			Capacity		Tare	Cost of construction in 1951	Maintenance costs per annum	Amortisation period
			Cubic feet	Tons				
14′ 0″	6′ 0″	6′ 4″	530	4	2 tons 1 cwt	—	—	—
		Height						
6′ 9″ to 7′ 0″	3′ 9″ to 4′ 0″	1′ 5″ to 1′ 10″	35 to 46	1 ½ to 2 ½	3 cwt 3 qrs	13	4 % on current replacement costs	Steel 10 Wood 15
	—		Approximately 360 sheets of glass	4 ¼	—	180	5 % on current replacement costs	No experience yet
—			—	—	—	(500)	—	(33)
4′ 10″	4′ 10″	5′ 3″	—	4	11 ½ cwt	61	No experience yet	No experience yet
	—		Gallons 850 (Not mentioned in reply which of the two shown in figures 11 and 12)	—	—	380	—	20
			—	—	—	325	4 % on current replacement costs	33
			Gallons			3 025	—	20
19′ 16″	7′ 6″		2 000	—	5 to 6 tons	(Not mentioned in reply to which type this datum applies)		(Not mentioned in reply to which type this datum applies)
14′ 6″	7′ 0″		1 440	—	4 to 5 tons		—	
	—		—	—	—		—	
						970	4 % on current replacement costs	33

CONT

Type of container	Figure	Designed for	Construction
			EIREA
Covered small	—	Sundry traffic	Composite construction steel and ti ber; rigid, without wheels
Covered large type 1 . . .	—	—	Light composite construction steel a timber; rigid, without wheels
Covered large type 2 . . .	—	—	Light composite construction steel a timber; rigid, without wheels
Open small	—	Bricks and tiles	Composite construction steel and ti ber; rigid, without swheel
Tank	—	Milk	Stainless steel; rigid with 4 wheels
			EGYPT
Covered large	—	Household removals and furniture	
			NEW ZEALA
Covered large 1	—	Household furniture and effects	
Covered large 2	—	Household furniture and effects	
Covered small	—	Household furniture and effects	

RS *(continued)*

Interior dimensions	Capacity		Tare	Cost of construction in 1951	Maintenance costs per annum	Amortisation period
	Cubic feet	Tons				
LWAYS						
″ 0 1/4″ 6′ 6 3/4″ 6′ 8 1/4″	284	2 ½	15 cwt	60	Not kwown	8
′ 5 1/4″ 6′ 8 1/4″ 6′ 8 1/2″	641	3	17 cwt	—	Not kwown	8
′ 1″ 6′ 0 1/2″ 6′ 0 1/2″	510	2 ½	19 cwt 1 qr	—	Not kwown	8
′ 6 1/4″ 3′ 9 1/2″ 1′ 8″	42.7	2 ¼	3 cwt 3 qrs 3 lb	—	Not kwown	10
—	Gallons 500	—	2 tons	—	Not kwown	10
LWAYS						
9″ 7′ 4″ 8′ 3″	770	—	—	—	—	—
ERNMENT RAILWAYS						
(Approximately) ′ 4″ 7′ 0″ 7′ 0″	(Approximately) 700					
—	500	—				
	300					

Fig. 3. — *British Railways.* Small open container (type C

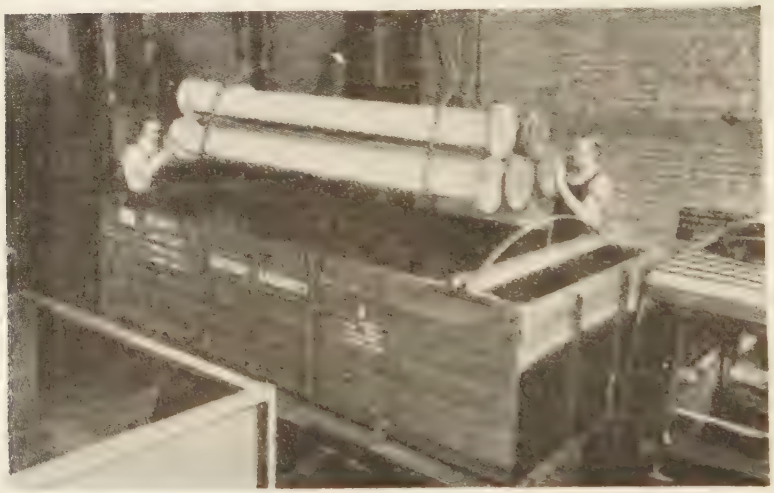


Fig. 4. — *British Railways.* Large open container (type D

fitted with vacuum operated brakes, so permitting running in express freight trains. Conveyance charges are raised only on net t weight of contents, empty tanks are returned free, tanks may bear the name, etc. of the hirer and are to his exclusive use. Some of the commodities carried are : chemicals, edible fats, glucose, molasses, oil and petrol, paint and varnish, tanning extract, printers ink, beer and wine, milk,

Fig. 5. — *British Railways.* Large covered container for bicycles (type B C).

Fig. 6. — *British Railways.* Large covered container for household removals and new furniture (type B K).

etc. For particulars see *appendix I* and figures 11 and 12.

We may conclude that containers for the conveyance of practically all description of traffic are available with *British Railways.* This is due to the fact that *British Railways* are as a rule prepared to collaborate with traders in the adaptation of containers

or the introduction of new types where special requirements are not met by containers already in use.

With *British Railways* containers are usually loaded in standard open wagons but considerable numbers of rail-chassis wagons are provided, particularly for special types of container and for tanks. No information as to this point, has been received from other Administrations.

that unloading of contents is the practice where no crane is available at the client's warehouse.

As appendices I and II show, the Administrations have not been in a position to give complete information about the cost of the container-, cranage-, rail- and road equipment. As to the number of men required to carry out terminal operations, the time taken, the average speed of the

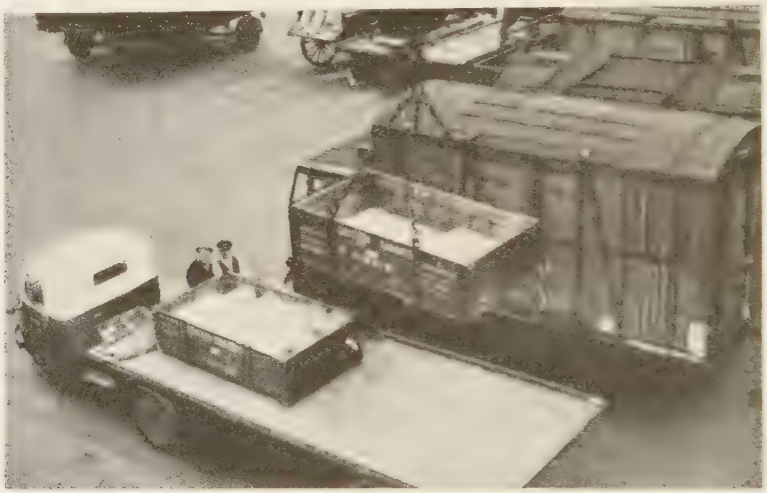


Fig. 7. - *British Railways*. Small shallow open container for building materials (type H).

Neither has any information been received about the private containers in use on the lines of some of the Administrations.

All containers mentioned render cranage facilities necessary for the handling at the stations. Information received about the cranes has been summarised in *appendix II* (figures 8, 10 and 12).

No information has been given as to road vehicles for the conveyance of containers nor as to the loading and unloading at traders' premises of containers or contents of same. It may, however, be assumed that most containers can be transported on normal standard open lorries or trailers and

journey and the cost of the equipment for the terminal transport, the only information received is, that with *Eireann Railways* the average time for the transhipment by crane varies from a few minutes to 15 minutes, whereas the average speed in delivery varies between 12 and 21 m.p.h.; with *British Railways* one or two men (in addition to the crane driver) are required for the purpose of attaching and releasing the lifting tackle.

4. — *Transport of road-trailers on wagons (rail/road trailer system) (same questions as under 3 b) above).*

The *South African Railways* consider the

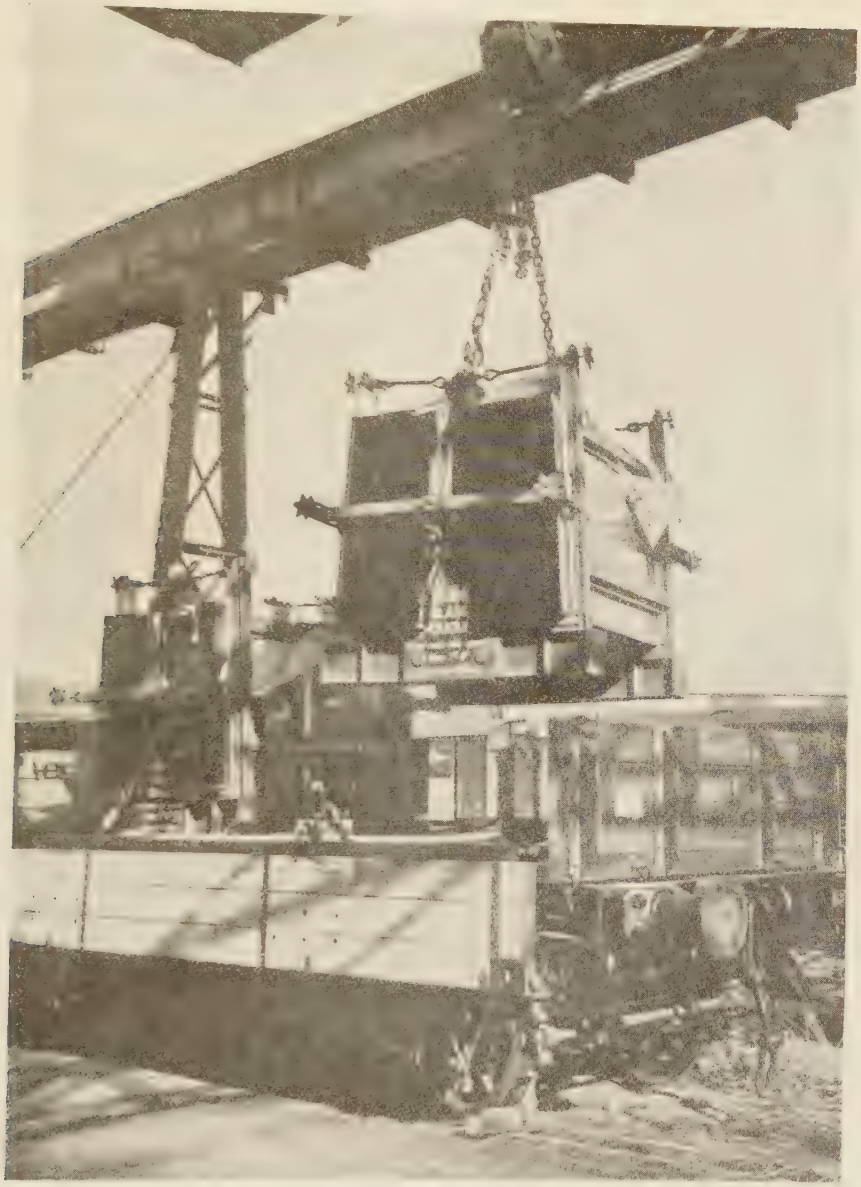


Fig. 8. — *Bulk glass cradle.*

Each cradle holds 4 1/4 tons of sheet glass in two packs, each pack leaning against centre of cradle. The packs are held in position by horizontal « gates » which fit into slots in the base and are tightened at top corners by tension wires.

Longitudinal movement of the sheet glass is prevented by centrally pivoted adjustable battens at each end.

Two cradles, each containing approx. 360 sheets of glass are mounted in one shock absorbing wagon. A marked decrease in breakages has resulted.

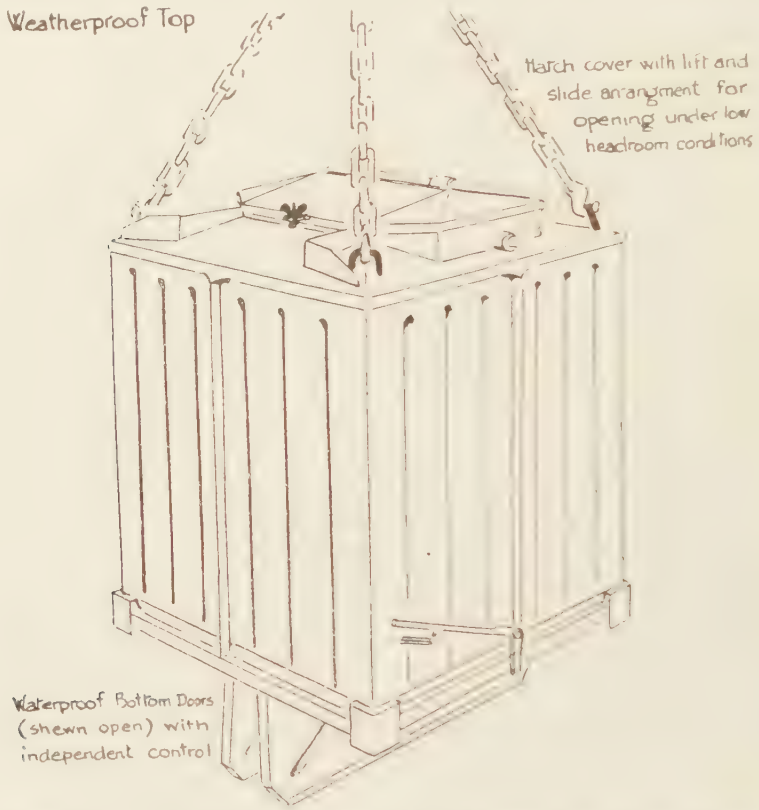
TYPE OF CRANE	Figure	Application	Construction
			BRI
Fixed :			
Hydraulic	—	In goods yards	—
Electric	—	In goods yards	—
Overhead « Goliath » or gantry crane (electric)	8	In goods yards	—
Rail traveling	—	—	—
Mobile			
—	—	On shed decks	Petrol, Diesel, Electric
—	10 and 12	In goods yards	Petrol, Diesel, Electric
—	—	—	Battery electric
			EIRE
. . . . .	—	—	Electric
Mobile	—	—	Ransome-Rapier Non-slewing-type
			NEW ZEALAND GOV
Mobile	—	In goods yards	Standard » Morris » typ
			RHOD
Mobile	—	—	Ordinary standard types

s

Appendix II.

Capacity	Cost of construction in 1951	Maintenance costs per annum	Amortisation period	Consumption of fuel and electricity
			years	
LWAYS				
to 10 tons	—	—	—	—
to 50 tons	—	—	—	—
to 10 tons	—	—	—	—
to 30 cwts	£ 825 to 2 190	1 s. 5 d. to 1 s. 9 d. p. h. according to capacity	10	3 to 5 h per gallon
to 8 tons	£ 2 500 to 6 660 both according to type of power, slewing or non-slewing jib and capacity	2 s. 5 d. to 3 s. 7 1/2 d. p. h. according to capacity, both based on 44 h per week, 52 weeks par annum	10	2 to 3 1/2 h per gallon
25 cwts	—	—	—	32 units (kW-h.) per 8 h duty
LWAYS				
—	£ 6 500		30	—
d 2 to 3 tons	£ 2 200	—	15	–
NT RAILWAYS				
to 5 tons	—		—	—
LWAYS				
–	–			—

introduction of these trailers. They are in use with *British Railways*, which have developed them under the same scheme as the non-wheeled demountable tanks, mentioned above, but are of a larger type than the latter. They are provided, with two or four wheels and can be hauled between firms' works by either mechanical horse or motor tractor. *Eireann Railways* have rail/road trailer tanks for conveyance of milk. No other rail/road trailers are in use with the railways under review.


Weatherproof Top
Hatch cover with lift and slide arrangment for opening under low headroom conditions
Waterproof Bottom Doors (shewn open) with independent control

Dimensions : 4 feet 10 inches square by 5 feet 3 inches high. Load : 4 tons. Tare : 11 1/2 cwts.

Fig. 9.

This container is designed for conveyance of traffics passing in bulk.

It is constructed of pressed steel and divided into two equal compartments which can be discharged either separately or simultaneously through bottom doors. Three are loaded on one wagon.

The weatherproof hatch cover has a « lift and slide » arrangement to permit opening under low headroom conditions.

Besides cement and limestone, the units will be used for alumina, dolomite, chemicals and other similar bulk traffics.

The rail/road trailers require the use of specially constructed rail wagons and must be positioned at an end-on dock for transhipment.

For particulars see *appendix I* and figures 13, 14 and 15. No further information has come to hand under this heading.

5. — *Transhipment of goods by technical means or by hand from the wagon to the road vehicle and vice versa (same questions as under 3 above).*

Transhipment of the goods by hand, by means of small implements, is still the customary method with all Administrations, especially, as *British Railways* indicate, « for consignments consisting of a large number of single packages, where crane or other mechanical methods would be uneconomical or impracticable ». Gantries and fixed and mobile cranes are used for heavy lifts, as containers, etc. *British Railways* at some stations, provide an electromagnetic attachment to the cranes for the handling of heavy iron and steel traffic (lifts up to 4 tons). As other equipment are mentioned : fork lift trucks, conveyor belts, gravity rollers, flats, pallets, hand barrows, etc. *British Railways* report to have developed special types of high capacity hopper wagons for the conveyance of commodities in bulk, such as grain, mineral ores, soda ash, etc. (cf. the bottom discharge container).

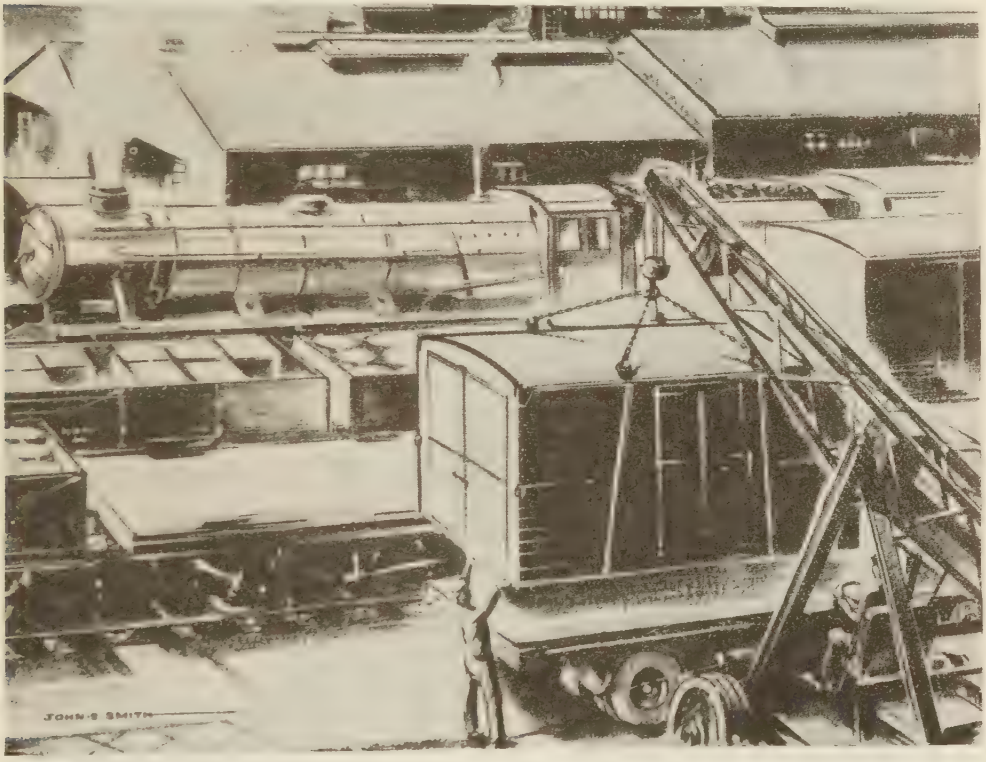


Fig. 10. — *British Railways.* Mobile crane transhipping large covered container.

Most Administrations make part of the equipment mentioned available to carriers

Fig. 11.
British Railways. Demountable non-wheeled tanks on rail chassis for two tanks

Fig. 12
British Railways. Demountable non-wheeled tank being transhipped by mobile crane

and clients to facilitate the loading of consignments to and from the railway wagons. Generally this technical service is restricted to certain stations.

Apart from the particulars, given in *appendix III* and the information about cranes, mentioned above, the only details received about the use of this equipment

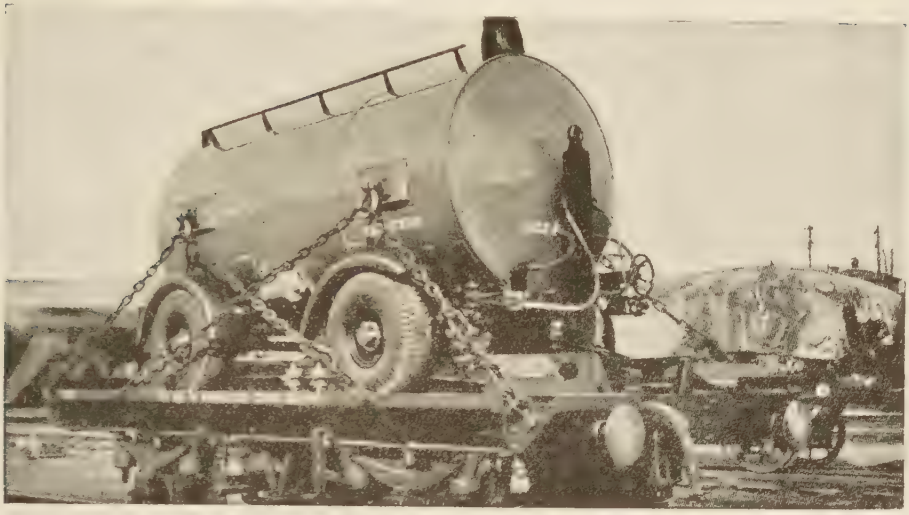


Fig. 13. — *British Railways.* Rail/Road tank on rail chassis for one tank.

Fig. 14. — *British Railways* Rail/Road tank being transhipped on end-on dock.

came from *British Railways* : with gravity rollers one man lifts each package on to the appliance and one man receives and stacks; flats are used like cargo boards at docks; the flat and its contents is transferred by crane from the cartage vehicle to open rail wagon, thus serving a purpose half way between that of a pallet and a container.

TYPE OF EQUIPMENT	Figure	Application	Construction
			BRIT
Power pallet truck	17	In sheds	Lansing Bagnall type; Pedestrian c trolled; Finger length 40" (Ri controlled power pallet trucks also used)
Hand pallet truck	—	In sheds	O.M.I.C.
Pallet	17	In sheds	Wood, two-way entry, single fac size 48" × 42", leading edges with rave tapering towards centre
Power truck	18, 19, 23	In sheds	Scott electric elevating platform (co plete with spare battery)
Stillage	18, 19, 20	In sheds	2 permanent hind-wheels; 2 ot wheels can be added by insertion wheeled handle
Tractor	17, 23	In sheds and goods yards	Scott electric; 12 cell 24 volt battery 200 Ah, covering a normal sh speed 3 1/2 to 4 1/2 m.p.h.
Internal station dray	21, 22, 23	In sheds and goods yards	Four wheeled
Wagon unloading machine	22	In sheds	Conveyor consisting of a power dri section (rubber belt 2 ft. wide 6 ft. long) and free running roller
Slat conveyor	21	In sheds	Hard wood slats attached to steel cha driven at a speed of 40 ft. per min by a 15 HP electric motor
Gravity roller Runways	—	In goods yards	Aluminium alloy, 14" rollers of 2 diameter, mounted at 4" pitch in lengths and complete with connect hooks and trunnions, weight 35 curved sections used as necessar
			EIREA
Hand lift truck	—	at some of the larger goods dep.	« Collis »
Loading tray	—		
			NEW ZEALA
Fork-lift truck	—	In goods sheds and goods yards	Standard design
Loading board	—	—	—
Tow motor	—	At larger stations in goods sheds and goods yards	« Lansing Bagnall »
Trailer	—	In goods yards	A flat tray mounted on wheels
			RHODE
Fork-lift truck	—	In goods sheds	Ordinary standard design
Tractor	—	—	Ordinary standard design
Trailer			Ordinary standard design

APPENDIX III.

apacity	Costs of construction in 1951	Maintenance costs per annum	Amortisation period	Consumption of fuel or electricity
LWAYS				
				per 8 h
—	£ 563	10 % (*)	10	5 to 6 units (kW-h.)
—	£ 98	10 % (*)	10	—
—	£ 1	10 % (*)	5	—
—	£ 469	10 % (*)	10	3 units (kW-h.)
—	£ 13.10.0	10 % (*)	5	—
—			—	—
—			—	—
—	£ 500	10 % (*)	25	8 units (kW-h.)
—	£ 20 per foot (installed)	10 % (*)	25	Varies with length and speed
—	£ 12.4 s. 0 d. per 8 foot length	—	unknown	—
		(*) Overall figure given in the reply to the relative question		
LWAYS				
—		—	—	—
—		—	—	—
ERNMENT RAILWAYS				
—	—			
—			—	—
—			—	
—	—		—	
LWAYS				
—				
—				
—			—	

Ad 1 — 5.

— If the means used on your railway have been preferred by you as a result of comparisons of cost, please give the results of such comparisons.

— Please indicate for each of the main categories of goods the average tonnage handled per hour for all these methods both mechanical and manual, mentioned before.

the shape of wheels, tyres, axles, brakes, springs, etc., which lie idle in the course of rail journey ». The *South African Railways*, on the contrary, deem a predominant objection against non-wheeled containers that they require cranage facilities. The mobile type of container on its own wheels « is better suited to local conditions on account of the large number of country stations where cranage facilities are not available ».

Fig. 15. — *British Railways.* Rail Road tank with tractor at a client's premises.

— Generally speaking what are the advantages and drawbacks of the means mentioned above as regards the use of loading platforms, shunting operations, speed of handling and what other considerations are there which can influence the railway operation in any way whatever?

The first part of this question has been answered only by *British Railways* (without giving figures) with regard to the use of non-wheeled tanks and containers as compared to those provided with wheels. Non-wheeled are preferred and encouraged to avoid « the use of specially constructed rail wagons, the waste of capital assets in

No comparative figures are available as to the average tonnage handled per hour. The *British Railways* and *New Zealand Government Railways* report ± 1.4 tons per man hour, which is the « overall figure for handled traffic » with B. R. and « the rate of work at main goods sheds covering various classes of goods » with N. Z. G. R.

As to the use of tanks and containers, the Administrations indicate the following advantages : speedier door to door service, elimination of intermediate handling, minimised risk of damage and loss, saving of time, cost and storage space for packing, elimination of returnable empties.

Fig. 16.
British Railways. Rail containers for short sea journeys.

Fig. 17. — *Palletization of inwards sundries traffic — Norwich.*

It is usual for pallets to be placed for loading outside the wagons but, in the photograph, a wagon has been partially unloaded and sufficient floor space cleared to enable an empty pallet to be placed inside the wagon. A pedestrian controlled power pallet truck is withdrawing the pallet which has been loaded with traffic for one cartage berth. The manual effort is reduced to a minimum in such instances.

Equipment used :

Pedestrian controlled power pallet truck — finger length 40″ (Rider controlled power pallet trucks are also used).

Wooden pallets, two-way entry, single faced, size 48″ × 42″, leading edges with 1″ rave tapering towards centre.

(« Bedstead » ends can be affixed to pallets to provide for loads which tend to be too heavy.)

Fig. 18. — *Scott electric elevating platform truck and loaded wheeled stillages.*

Fig. 19. — *Loaded stillage in elevated position on scott electric truck.*

A. o. with a view to eliminating shunting operations and to speeding up transhipment, most Administrations prefer mobile cranes to fixed ones.

As to loading platforms, *British Railways* inform that these are not normally used for full loads, as direct loading from rail to road vehicle is quicker and cheaper. The simplest possible shunting arrangement is for wagons to be put in an open yard for discharge, though in certain cases, e. g. for protection of certain traffics from the weather, the complications of shunting to warehouse, must be accepted.

Fig. 20. *Alternative method of movement of stillage for short distance by insertion of wheeled handle.*

B. — *Part loads; parcels traffic* (*).

Small containers up to 3 m³ in size (106 cubic feet), loading trays (pallets, box-pallets) and other loading gear.

— What handling gear is used for the transport within the station and to clients' premises with small containers, loading trays and other loading gear (for example small tractors, fork lift trucks, cranes mounted on road vehicles, etc.)?

— Give a description of these technical means, appending if possible photographs and sketches sufficiently detailed to give a clear idea of the means used.

— Please give the following details for these technical means :

What handling is necessary for the terminal transport?

How many men are required to carry out each of these operations?

How long do they take?

What was the cost of purchase in 1951 of the means used?

What is the average life of these means?

What sinking fund rates are used?

(*) *British Railways* report to have taken the term « Parcels Traffic » to refer to small consignments passing by goods trains. None of their answers relate to parcels traffic conveyed by passenger train to which facilities of the nature discussed are not generally applicable.

Fig. 21. — *Deck conveyor.*

The latest type of deck conveyor (Lawley St., Birmingham) is 360 ft. long, and 3 ft. wide. It is formed of hard wood slats attached to steel chains driven at a speed of 40 ft. per minute by a 15 HP electric motor.

Packages are sorted from the conveyor either on to internal station vehicles for tranship traffic, or on to moveable trays for town delivery. The latter are subsequently moved to appropriate « town » section where the packages are again sorted and transferred to cartage vehicles for delivery.

How much fuel or electricity and lubricating oil are used for transhipment operations on the one hand and transport on the other?

Can you give any figures for maintenance and repair (per year and per kilometre for the means of transport and per hour of use for the transhipment gear)?

What is the average speed from one end of the journey to the other (i.e. from the station to the clients' premises and vice versa) with these means of transport?

None of the Administrations covered by this report have in use containers as are meant here.

British Railways, Eireann Railways, New Zealand Government Railways and *Rhodesia Railways* have supplied information about the use of loading trays and other loading gear. Available data about mechanical appliances have been summarised in *appendix III.*

Palletization of inwards sundries traffic is a recent innovation on *British Railways,* being introduced at Norwich in May 1951, but being extended to other depots (Birmingham-Hockley, Oxford and Bristol as yet).

The method adopted is to place pallets, one for each road vehicle loading checker on the platform alongside the wagons. Traffic is sorted and loaded manually on to the pallets, which, when fully loaded, are moved to the appropriate cartage berth by power pallet or fork lift trucks. Detachable sides are provided for fixing to pallets when loads tend to be top heavy. At the cartage berth, traffic is off-loaded to the respective delivery vehicle.

This method involves no structural alterations to existing premises, has not reduced actual handling, but has eliminated the lenghty manual barrowing of comparatively small loads. Pallet loads varying from 10-25 cwts, are transported by the power trucks with greater speed and fewer staff.

With palletization of sundries traffic it is usual for two men to unload traffic to pallets. One man operates the pallet truck transporting the loaded pallets to cartage berths, where the number of men discharging varies according to the number of road vehicles being served.

In similar manner to the palletization method, electric trucks with elevating platforms are also used in conjunction with stillages, which have a pair of wheels at one end (figures 18 and 19). The object of the wheels is to enable the stillage to be moved for short distances without using the electric truck by inserting wheeled handles at the opposite end (figure 20).

Pallets and stillages are not in use for throughout conveyance of smalls traffic, but are in regular use for moving sundries traffic within the station at the above mentioned places.

The other mechanised system of the *British Railways* for the handling of miscellaneous traffic, which is well known already, is briefly as follows. Fixed and portable moving belt conveyors and wagon unloading machines, on the endless belt principle, are used for transferring sundries traffic from wagon to road vehicle or to primary sorting point for subsequent movement to road vehicle (see figures 21 and 22). One or two men unload traffic from each wagon to conveyor, but the number of men discharging from conveyor varies according to the number of road vehicles being served and the density of traffic.

Power trucks of various types, low capacity cranes, and internal road vehicles are also used for the same purpose (figure 23).

The time occupied by (each of) the operations varies according to the type of traffic, the length of conveyor (if in use), number of « sorts » to be made, size and design of the station, type of handling, bonus scheme (if any), and possibly, other factors. The man hours per ton figures for sundries traffic at the following stations will give some indication (figures inclusive of all operations between wagon and road vehicle or wagon and wagon transhipping).

	Man hours per ton : before mechanisation.	*after mechanisation.*
Very large shed — Birmingham (Lawley St.) (Slat conveyor for inwards sundries and direct loading outwards sundries)	1.60	1.29
Medium — large — shed Norwich Thorpe (pallets, and power and hand pallet trucks; fig. for inwards sundries only)	1.80	1.38
Small — medium shed — Scarborough (Slat, conveyor : fig. for inwards sundries only)	1.51	0.86

Fig. 22. — *Wagon unloading machine.*

This is a power driven conveyor, set at right angles to the wagon; the « nose » is inserted into the wagon doorway, and the appliance is fed by two men working inside.

The power driven section is a rubber belt 2 ft. wide and 6 ft. long, to the end of which free running rollers are attached. Drays may be ranged round the machine — on each side and at the end. Each succeeding package arriving on the rollers pushes the others forward. Sorting staff remove each package to the appropriate dray.

Fig. 23. — *Internal station dray and tractor.*

The function of the « internal station dray » is to convey packages to appropriate town delivery section where the goods are sorted to the correct vehicles, or to convey tranship traffic to the forwarded wagons, which is done by a process of perambulation from wagon to wagon.

The latest method of moving these « internal » drays is by means of Scott tractor. This appliance is geared to give a speed of 3 1/2 to 4 1/2 m.p.h.

A 12 cell 24 V battery of 200 Ah capacity is capable of covering a normal shift, but where 24 h working is required, batteries can be changed.

APPENDIX IV.

CUSTOMARY PACKING

TYPES OF PACKING	Gr. Br.	Egypt	Eire	India	Nw. Zeal.	Rhodesia	S. Africa
Wooden cases							
Wooden crates and frames							
Wooden slatted crates and chips							
Wooden casks, barrels, kegs							
Fibreboard cartons							
Fibreboard kegs							
Iron drums and kegs (Metal containers)							
Tins (Metal containers)							
Iron cylinders (Metal containers)							
Welded metal crates							
Fish boxes of wood or metal							
Glass carboys, jars, bottles							
Hessian and gunny sacks and bags							
Hessian and gunny wrappers							
Mats							
Paper wrappers							
Oil paper or other liquid proof material							
Ply-paper sacks and bags							
Hampers							
Baskets							
Straw, sawdust							

Eireann Railways have hand-lift trucks to transport loading trays and mobile cranes for heavy loads at their disposal at the principal depots. *Rhodesia Railways* and *New Zealand Railways* report to make use of tractors, trailers, fork-lift trucks and mobile cranes of ordinary standard types. Details available about this equipment, have been summarised in *appendix III*. The only information received as to the use, cost and output per man hour is the figure of 1.4 ton per man hour in main goods sheds of *New Zealand Railways*.

— If the means used on your railway have been preferred by you as a result of comparisons of cost, please give the results of such comparisons.

— What are the advantages and drawbacks of the technical means mentioned above as regards speed of handling, damage, possible loss of space on the wagons, the saving in labour, space taken up in the goods depots?

No comparison of cost has been supplied by any of the Administrations.

Only general remarks about advantages and disadvantages of some mechanical methods are made. Acceleration of the bridging of distances and the employment of fewer hands are generally stated as advantages of mechanization. In addition, the handling of heavier parcels is made easier by mechanization.

With the fork-lift truck, the *Rhodesia* and *New Zealand Railways* also put forward the advantage of better utilization of the space in sheds, stacking goods to a greater height being rendered possible.

The *British Railways* give the following information : « Mechanization has been adopted mainly on the score of net economy, but increased efficiency and saving in manpower (particularly under present day conditions) have also provided ground for such development. In many cases advantage is taken of the lower cost of handling to deal with additional transhipments through a mechanized depot. Damages are not increased and occupation of wagon space is not affected. On narrow platforms the use of stillages, pallets and power trucks may be impracticable and in these circumstances consideration is given to the alternative of fixed or portable conveyors ».

PART II.

What are the best conditions of use of containers for small miscellaneous traffic (dimensions of the containers, conditions of ownership, tariffs)?

A separate chapter of the questionnaire has been devoted to this subject, which, however, is restricted to containers up to 3 m³ (106 cubic feet).

The questions have reference to ownership, information about construction and cost, average turnround, average distance covered loaded, empty runnings and steps to reduce same, remunerativeness, transport and haulage rates and the use, if any, for the grouping of consignments of parcels traffic from station to station.

None of the Administrations has containers as meant here in use for the transport of small miscellaneous traffic. The *Eireann Railways* state that some shippers do make use of them, but that they cannot supply information about them. The *Egyptian State Railways* have introduced refrigerator containers for perishables, meat, butter, cheese, fruits, fish and similar traffic in 1935. As this service was not patronized, it has been suspended since.

Under this heading some Administrations have supplied information relating to large containers. This information has been dealt with in Part I.

PART III.

What are the packing types to be recommended?

The questions from the list of questions are dealt with in the following grouping :

1. Customary packing;

2. Regulations and application thereof;

3. Requirements to be demanded from packing types:

4. Research into packing;

5. Causes of damage.

1. — *Customary packing.*

— *What types of packing are normally used by consigners of goods over the lines of your company :*

a) *in inland services;*

b) *in international services ?*

Most of the railways concerned in this research only mention the means of packing evidently most in use with them, without specifying the kinds of goods for which they are used. The *British Railways*, however, mention at the same time the most frequent application as follows :

— wood cases, crates, barrels, casks, kegs and frames — for general goods;

— fibreboard cartons — for such commodities as textiles, tobacco, confectionery and tinned goods;

— fibreboard kegs — for powders, etc.;

— iron drums and kegs — for paint, putty, oils, etc.;

— tins — for paint and various other liquids and semi liquids;

— hessian wrappers and straw — for furniture;

— hessian sacks and bags — for potatoes, flour, grain, sugar, cement and other powders;

— iron cylinders — for gas under pressure;

— glass carboys housed in flat bottomed cases, crates or tubs — for acids;

— ply-paper sacks and bags — for various commodities, such as cement, plaster and sugar, mainly in full truck loads;

— welded metal crates — for pottery and earthenware;

— hampers — for textiles and laundry work;

— slatted crates and chips — for salads and soft fruits;

— fish boxes of wood or metal providing adequate ventilation and drainage.

The *Indian Railways* gave very detailed information, for which see § 2.

The most general means of packing are wooden cases and crates. Cardboard boxes begin to belong to this category more and more. These general means of packing are often used as outer packing for means of packing of more restricted application, such as tins and cardboard kegs; generally less for better protection than for enlargement of the units and for improvement of the shape, which is of importance for handling and for stowing parcels.

No distinction is made by the Administrations between packing for inland and for international services.

2. — *Regulations and application thereof.*

— *Has your Company any regulations concerning packing, and if so, what are they :*

a) *do these regulations apply to certain types of packing ?*

b) *do these regulations apply to certain goods ?*

All reporting Administrations have more or less detailed regulations concerning packing.

The tenor of these regulations is that the packing material must afford efficient and suitable protection to the merchandise.

The regulations of the *Indian Railways* for packing are given in detail (59 pages in print) and refer both to specially mentioned goods and to the packing types themselves. (Indian Railways Conference Association : Packing conditions and the goods to which each applies by P. H. Sarma, General Secretary, New Delhi, 27th May 1950.)

E. g. Packing condition 23 :

« Must be securely packed in strong wooden boxes, bound with steel strappings, clipped and sealed or steel wire fastened under tension lengthwise and breadthwise or bound with one continuous length of

mild steel strapping at both ends, nailed to each plank — each plank having its own clip :

« cigarettes, clocks, narcotic medicines, guns, watches ».

The packing conditions in this detailed regulation are the minimum required.

With the *British Railways* detailed arrangements, applying both to goods and to packing types, are included in the General Classification of Merchandise Booklets, which are available for purchase by traders. As goods, for which special types of packing are stipulated, are mentioned : « goods known to be highly susceptible to damage » as eggs, preserves.

The regulations of the *Eireann Railways* also refer to packings types (e. g. fibreboard) and to certain goods as stoneware, earthenware.

The *New Zealand Railways'* packing regulations have as a general rule that « where goods are described as « packed », it is intended that they shall be properly and securely packed in cases, casks, etc. for safe transit by rail, in the manner in which such goods are usually packed in the trade ». The Railways reserve the right to decide whether any goods are packed within the meaning of this regulation ! A special regulation as regards fibreboard packing should be mentioned : « in the case of fibreboard containers not fitted with corrugated-card or fibreboard divisions the gross weight of the package does not exceed 65 lbs ». The *British Railways* have a similar prescription.

South-African, Egyptian State, Rhodesia and *Ceylon Government Railways* do not insist upon particular types of packing. Rail-users are largely left to their own methods of packing, though *South African Railways* made special provision for the dimensions and construction of crates or cases, which are to be utilized for the packing of a certain few commodities, such as porcelain-enamel baths and cast-iron stoves.

All Administrations report to have special regulations concerning explosives and other goods, which may cause danger.

— If your regulations apply to certain goods, is this due to the fact that the regulations applying to certain types of packing are not satisfactory ?

The *British* and the *Indian Railways* give a direct answer to this question in the affirmative, which is easy to understand as they have detailed regulations both for special goods and for special packing types. The *Eireann Railways*, which also have regulations of two kinds, give an indirect answer to this question in the negative (« our regulations are satisfactory ») without stating reasons.

— Have your Company's regulations about packing been influenced by the extent of the Company's responsibility from the point of view of damage during transport ?

All reporting Administrations answer in the affirmative.

In this connection, the *British Railways* state that some types of traffic, however packed, are not accepted for conveyance at railway risk owing to their inherent risk of damage (e. g. honey in the comb, fluorescent lighting tubes, etc.) *South-African Railways* have a special regulation, stating that furniture is accepted and may be consigned entirely unpacked at railway risk upon payment of a small surcharge to the normal rates. Motor cycles and sidecars, *even when packed*, are only conveyed at Railway risk upon payment of 25 % surcharge.

Are your Company's regulations about packing generally respected ?

Generally the railways' regulations about packing are respected by the consigners, as could easily be expected. *British Railways* mention that some small traders show lack of appreciation of the importance of correct packing. In addition they observe that under present day conditions it is often difficult to make the traffic comply with the regulations as a consequence of difficulties in obtaining the suitable packing materials.

— If your reply to the preceding question is in the affirmative, how is the fact that the regulations have been complied with checked ?

With most railways the checking is exercised by the accepting staff. With *New Zealand Government Railways*, General Claims Agents make general supervisions and investigations. With *British Railways* the initial check is exercised by the carman, when collecting traffic. There is also a general check at the stations, which includes traffic carted in by traders. These checks are supplemented periodically by specially appointed inspectors engaged for the purpose. Whenever possible, a check is also made on submission of a complaint, or claims for damage, to ensure that the packing was in accordance with requirements. This will undoubtedly be the case with most railways.

— Are the employees, responsible for dealing with claims for damage, experts on the question of the quality and suitability of the packing of damaged consignments ?

As is evident from their answers, most railways are under the fortunate circumstance that those of their staff who must deal with claims, are experts. *Egyptian State Railways* are reticent about it and *South African Railways* reply in the negative, but add that in the course of time, however, many acquire a fair knowlegde in regard to the quality and suitability of packing necessary to avoid damage to consignments. It's an interesting feature, that *British Railways* give consideration at Headquarters level and District Offices to the extension of the policy of allocating staff on a « commodity » rather than « value of claims » basis, as this tends to increase expert knowlegde. In addition expert knowlegde for certain types of packing is available through the medium of B. R. Executive Central Claims and Packing Authority, which may serve itself of the co-operation of B. R. E. Research Department.

— What is the attitude of your Company towards consignors who do not comply with the packing regulations ?

British, Eireann and *South-African Railways* bring any failure to the notice of the consignor and every effort is made to obtain his co-operation in having goods suitably packed; and, if necessary, the consignor is given suitable guidance. If at the end the consignor is not prepared to comply with the regulations the traffic will not be accepted at Railway risk and claims not favourably considered.

In this connection, the *British Railways* report that when particular types of packing do not comply with the regulations governing this type of package, the traffic will only be carried :

— at « Owner's risk conditions » where « Owner's Risk rates » are available, or

— under the conditions applicable to « Damageable Goods not properly protected by Packing », which, apart from negligence, relieve the Railways of responsibility for damage.

It is quite probable that the attitude of *British, Eireann* and *South-African Railways* as above mentioned, is also adopted by the other Administrations, which in their replies confine themselves to stating that goods unsuitably or inadequately packed are excluded from transport or accepted at owners' risk only.

— Is the competition of other methods of transport such that it is inadvisable to insist on the standard of packing railway transport would normally require ?

The majority of the railways who have been consulted, do not think that the competition of other means of transport is of such a nature that any change of the normal railway standard of packing would have to be considered.

The *British Railways*, also replying in the negative, are of opinion that their competitive position has been strengthened by the introduction of the railway-owned containers. The *South African Railways*

account for their negative answer with the information « road competition is controlled », but add : « road operators frequently adduce the cost of packing necessary for rail conveyance as a factor in favour of road transport ». Only the *Egyptian State Railways* have contrary views, but do not give a further explanation of them. The *Eireann Railways* give an indirect answer in their information that « competition of other means of transport does certainly influence our approach to the general question of packing ».

— Is any provision made in your tariff system for special reduced rates when goods are carried in certain approved types of packing?

British and *Eireann Railways* have made special provisions by means of lower classification for certain goods in respect of a higher standard of packing. The *South African Railways* (as mentioned already) do the opposite and enhance the rates for furniture (10 %), and cycles consigned at Railway risk, when these items are *not* securely packed in approved cases or crates.

— Has it been your experience that the granting of reduced rates for the use of packing conforming to your standards has led to these being used more frequently?

British and *Eireann Rrailways'* experience is that these reductions have indeed encouraged the use of better types of packing.

3. — *Requirements to be demanded from packing types; special rates.*

— Have the types of packing normally used by consignors proved satisfactory? If not, why?

Generally the types of packing used by consignors prove to be satisfactory. The *South African Railways* make an exception for multi-wall paper sacks, as these are readily susceptible to damage by interior projections in wagons, unless adequate dunnage is used. The *Rhodesia Railways* add that hessian bales are only satisfactory when of double thickness, whereas cardboard cartons must be new and properly sealed.

— What types of packing do you think are the best for the different kinds of goods carried?

What is the best way of packing depends, as a matter of fact, on a variety of factors, which may differ in accordance with the nature of the goods and the circumstances. For a long list of goods, the Administrations would have to make a study of all these factors, in order to be able to give a satisfactory reply to this question. With the exception of the *Indian Railways*, the detailed regulations of whom have already been mentioned, they evidently have had to refrain from this. Most Administrations have confined themselves in their regulations to indicating the required packing only in the cases where necessity arises.

Apart from this, they have given the following information as to their opinion about this question. *British Railways* and *New Zealand Railways* chiefly point out the connection which there is between the kind of goods and the packing. The *Rhodesia Railways* recommend wooden cases for bottled goods, cardboard for clothing and soft goods, crates and heavy wooden cases for machinery. With *Egyptian State Railway* and *Eireann Railways* wooden cases have proved to be the most satisfactory, though in Eire fibreboard packages, made in accordance with standards for all goods, even the most fragile, have yielded satisfactory results.

— What characteristics should such packings have in order to make them :

a) *firm;*

b) *stackable;*

c) *possible to ventilate them?*

Here too, an elaborate study would be necessary for a complete answer. The *Indian Railways* give a few instances: gunny bags : securely stitched; wooden cases : securely fastened with steel strap-

ping or wire; tins, drums and cans : properly soldered. *British, New Zealand* and *Rhodesia Railways* give some general characteristics :

a) sufficient rigidity and strength to carry contents;
b) uniform size;
c) easily handable sizes and weight;
d) slatted tops, bottoms or sides, allowing free passage of air (vegetables, soft fruits).

— Are there any circumstances which make it necessary to make additional stipulations as regards these types of packings due to :

a) *the climate;*
b) *the situation during the journey;*
c) *transhipment during the journey;*
d) *use of mechanical or other gear;*
e) *the quantity of goods sent in (incomplete or full loads);*
f) *risks of theft;*
g) *other circumstances?*

This question actually implies a specification of some of the factors, the study of which is necessary for correctly answering the aforementioned questions. In connection with this, the answers to the question in point did not yield new views.

— If any provision is made in your tariff system for special reduced rates when goods are carried in certain approved types of packing, give details about your standards and a detailed summary of these rating regulations.

No detailed information about the standards of packing has been received in this connection. Information about the rating regulation has been cited above.

— Are you of the opinion that packing should or should not be re-usable, i. e. returnable or not?

What types of packing are used more than once for the same type of goods in your country? And what is your experience in this connection?

At first sight the question seems to be of little importance, for it will hardly interest the railways whether the packing is re-usable or not, provided it is good, i. e. comes up to the respective requirements. From this point of view it is obvious that the tenor of the answer is : « This depends upon the durability of the packing. Generally we do not insist on the use of new packing, provided the packing used is in good condition ». Only the *Egyptian State Railways* reply : « preferably not », without giving further reasons. As examples of packing against the re-use of which are no objections on the whole, are mentioned : wooden cases, crates, barrels, steel drums, hessian and gunny bags, baskets, tins. Objections are raised against re-using fibreboard cases, hessian cloths and mats and multi-wall paper sacks, though, as *British, Egyptian State* and *Eireann Railways* emphasize, present circumstances preclude rigid application of this principle.

— What do you think of types of packing that can be folded up?

It is generally acknowledged that such packing types give an attractive saving of space when being returned, but it is also generally required that foldability must not detract from rigidity.

— Do you make any provision for reduced rates :

a) *for the transport of returned empties used in connection with goods transported by you on the outward journey;*
b) *for the transport of empties destined for goods to be shipped by rail subsequently?*

— Are these special rates applicable to :

a) *types of packing not returnable;*
b) *types of packing returnable;*
c) *both types?* (*).

(*) The reporter may draw the reader's attention to the fact that the French text of this part of the question is entirely different and reads as follows (translated) :

« Are these special rates applicable to :
a) all types of packing;
b) types of packing complying with certain requirements.
In case *b*), what are these requirements? »

— Have the reduced rates granted for returned empties encouraged the use of types of packing which can be used more than once?

British, Rhodesia, South African and *New Zealand Government Railways* have made the provisions as mentioned in the first part of this question, by means of special scales. The reductions of *Rhodesia Railways* for empties are not specifically confined to those used in connection with or destined for goods shipped or to be shipped by rail. *British Railways* only grant the reduction when the empties are returned to the station from which the loaded traffic was despatched by sender, whereas special rates for the transport of empties for subsequent conveyance are only applicable in the case of grains, fish, fruit, vegetables and flowers. *South African Railways* only charge the special reduced rates when the empties are returned by the original recipient, from the original receiving station to the original consignor at the original sending station. Special rates for empties to be subsequently shipped by rail do only apply to tin, iron or steel containers (excluding decorated or fancy tins and tins designed for other uses after serving as trade containers) which are manufactured at and forwarded at owner's risk direct from a South African factory to a factory for packing the manufactures of the latter. Such containers are classified in a tariff one class lower than that applicable to empties generally. To enjoy this facility, containers of less than four gallons capacity require to be packed. *Egyptian Railways* have suspended reduced rates for returned empties since the war, *India Railways* have no special rates.

Though the special rates generally apply to types of packing not re-usable as well as re-usable (the first often being reconditioned), *Eireann, New Zealand, Rhodesia* and *South African Railways* think it a reasonable assumption that the reduced rates for returned empties have encouraged the use of re-usable types of packing. *British Railways* are of the opinion that the initial cost of packing to the trader and availability of packing materials are the governing factors at the present time.

— In your opinion are the reduced rates mentioned in the preceding question justified technically from the point of view of cost to the railway?

— If your reply to this question is in the negative, what considerations have led you to grant these reductions?

Only the *Eireann Railways'* answer to the first question is in the affirmative. It is replied to in the negative by *Rhodesia* and *South African Railways*, whereas *British Railways* reply that in view of the heavy claims bill for loss of or damage to returned empties it is doubtful whether the reduced rates are economic.

The *British Railways* explain this situation by the divergency between the « inflated » value of empties nowadays and the conditions at the time the returned empties scales were introduced. That these scales are still in force, is due to the fact that as the low rates are conditional upon the loaded traffic passing by rail, traders have an inducement to use rail services. *South African Railways* motivate their reduced rates for returned empties with the general interests of the country. These reductions contribute towards conservation of materials. Moreover there is a railway interest, as the traffic is regarded as additional and in many cases, trucks, which would otherwise be hauled empty, are used for the conveyance thereof, thus making some contribution to earnings. *Rhodesia Railways'* special rates for empties are meant to encourage the use of rail services.

4. — *Research into packing.*

- Is there any Organisation in your country carrying out researches into packing on a scientific basis?

— If your reply to this question is in the affirmative, what are the relations between your company and this organisation?

— *Are you of the opinion that the results of these researches into packing will lead to a reduction of damages? If so, give some concrete and striking examples.*

Only *British Railways*, *New Zealand Government Railways* and *South African Railways* report relations with an organisation in their country, which carries out researches into packing on a scientific basis. In Great Britain, five organisations outside the *British Railways* bring to the notice of the latter all developments in packing; in addition, the B. R. confer with these organisations when necessary. The *New Zealand Government Railways* are represented on the various Standards Institute Committees by the General Claims Agent. The *South African Railways* contribute to the subsiding of the S. A. Bureau of Standards and are represented on many of the committees. Up to the present, the Administration has preferred to request consignors to consult the Bureau of Standards direct rather than refer cases there on behalf of the consignors. The Administrations expect of these researches a decrease in damage, as may be easily conceived, though the process is a continuous and gradual one. The *British Railways* give the following examples of results which have been attained :

a) method of assembly of certain makes of radio and television sets has been improved to render these articles less susceptible to damage;

b) improved type of internal packing for eggs in cases;

c) introduction of cardboard envelope for protection of bicycles conveyed singly.

5. — *Causes of damage.*

— *What is, in your opinion, the main cause of damage :*

a) *the kind of goods;*

b) *the condition of the packing;*

c) *the handling of goods;*

d) *the transport itself?*

The majority of the Administrations concerned in this investigation, do not mention any main cause of damage, but attribute the damages to combinations of the causes mentioned in the question. The *New Zealand* and the *South African Railways* state that the handling of goods is the main cause, but *British Railways* consider the shortage of packing materials as main cause and add : « In spite of efforts to maintain high standards, indifferent handling and shunting may aggravate any weakness already present ». *Egyptian State Railways* also mention shunting and packing.

— *Does your Administration check the transport and handling of goods by means of certain suitable apparatus (shock recorders)? If so, what type of shock recorder is the best and why?*

— *If your Company makes use of shock recorders, are these merely used to control the transport or are they used to investigate the methods of stacking and types of packing used?*

Only *British Railways* make use of shock recorders to record transit oscillations and shocks. They are also used to reveal handling deficiencies by inserting them in the package. The type of recorder mainly used by the *British Railways* consists of an eight-day clockwork movement with a paper tape upon which excessive movements during transit are charted and graded. The *South African Railways* have already acquired shock-recording apparatus, but did not bring it into general use yet.

CHAPTER II.

GENERAL VIEW ON THE QUESTION.

PART I.

What are the quickest and most economical means to carry out door to door service for railway transports?

The problem of the door-to-door transport has, also as a consequence of the great development of the automobile, attracted

in a high measure the attention of the railways.

A definition of this problem can be omitted here, on account of its having been dealt with by the International Railway Congress Association in 1949 and 1950.

For 1952 an inquiry into the speed and the efficiency of the various methods applied in door-to-door transport, has been placed on the agenda.

A) *Full loads.*

1) As to the *siding*, the oldest means of door-to-door transport of the railways, the 15th Congress of the Association (Rome 1950) a. o. drafted the following summaries :

« ... The oldest solution to the problem on the railway is the private siding. It would appear to be to the interest of the railway to do all it can to increase the number of such sidings. Certain railways appear to be in this respect much more ahead than others. Some railways are prepared to share in the capital costs of providing private sidings on condition that the traders concerned guarantee an adequate volume of traffic » (1).

« It is recommended that all facilities should be provided at railway stations which their size and layout permit, for example, the letting of sites and the provision of handling equipment » (1).

The answers to the present questions concerning the sidings, have hardly shown anymore than a confirmation of the above conclusions and of the data which for a number of Administrations covered by this report, had been recorded by Mr. A. A. HARRISON in the *Bulletin* of May 1950 (p. 775 seq.).

Siding service is offered generally and there is a unanimous feeling that this should be encouraged as much as possible. With one exception, the Administrations do not have the intention to encourage development of siding service by undertaking all or part of the capital cost of the siding. They prefer to place sites and premises in railway yards at the disposal of traders on attractive conditions. In this connection, the « railhead distribution » system of British Railways deserves special attention.

One Administration only could give data about the importance of using siding at either one or both ends. The figure mentioned was 33 1/3 % of total tonnage.

2) As to the other methods of door-to-door transport of the railways, the 15th Congress of the Association (Rome 1950) has a.o. stated the following :

« The attention of the Congress should be drawn to the importance of terminal transport as regards the cost of transport between clients who are not linked up with the railway. The reduction in the cost of terminal operations, whether they be in the handling at stations or in the haulage between the station and the premises of the clients is of considerable importance, increasing when short distances are involved » (1).

« When clients are not linked up by private sidings, the railway does not seem to have taken sufficient interest to date in the other methods which enable the door-to-door technique to be obtained, using the railway for the main part of the journey. It would appear advisable to make great efforts in this direction » (1).

« A certain number of solutions making door-to-door transport possible have been perfected : containers, rail-road trailers, wagon-conveying-trailers. It seems that up to date experience does not warrant the recommendation of one rather than another of these solutions. The different railways should continue their trials. It is not certain that a single solution can solve all the problems arising... » (1).

This time the inquiry has been bent upon the collecting of data concerning speed and efficiency of the various methods of door-to-door transport, especially as concerns the terminal operations. Such documentation could offer valuable help to Administrations in their trials, when considering the advantages and disadvantages

(1) Rome, Congress 1950, Question VIII, summaries 6 and 13, *Bulletin* for August 1951.

(1) Rome, Congress 1950, Question VIII, summaries 3, 7 and 9, *Bulletin* for August, 1951.

of the different solutions of the door-to-door problem under the circumstances prevailing in their countries.

No doubt, the Administrations concerned have provided much interesting information, which the reporter has summarized in — as he hopes — conveniently arranged appendices to this report. Nevertheless, it has to be acknowledged, that several data which could have been of great value for the comparison of cost, appeared not to be available and therefore were not mentioned in the answers. In connection with this it is necessary to point to the fact that the answers to questions concerning comparisons of cost made by the Administrations, only contained general expositions of advantages and disadvantages of certain systems, whereas the confirmation in cost figures failed to be added.

Transhipment of the goods by hand whether or not by means of small implements, is the customary system with all Administrations. For heavier pieces, cranes of different types are in use. The provision of some handling equipment is customary with most Administrations. It is a reasonable assumption that the standard of wages influences the extend of the use of appliances.

Transhipment directly from rail- to road vehicle is generally judged the quickest and cheapest method, also with a view to simplifying shunting operations. For this last reason, *mobile cranes* are preferred to fixed ones.

There is but a limited *use of containers* and demountable tanks. Only *British Railways* have a fairly developed system. *Eireann Railways* have taken up the introduction on a larger scale. In view of the fact that one of the (many) advantages of containers is the elemination of intermediate handling, the standard of wages will be among the factors which are of influence on the use of containers.

Rail-road trailers are in limited use with *British* and *Eireann Railways*.

An interesting feature is the principle, recognised by *British Railways* as a basis for their development of door-to-door transport : « Door-to-door service is best given by combining the maximum use of ordinary cartage equipment with the use of containers and ordinary rail wagons. Every departure from the ordinary means the provision and maintenance of special and expensive equipment, for which full employment may not be available. ». This might be considered as a straight answer to the question under review in this part of the report, for the circumstances prevailing in Great-Britain. That it is not generally accepted, appears from the information of the *South-African Railways*, which prefer rail/road trailers, because these do not require cranage facilities at the stations. It has been the very aim of the present investigation to supply the Administrations with the cost figures and other explanatory data, which they require to be able to judge the value which these and the like statements may have for them.

B) Part loads; parcels traffic.

The Administrations concerned in this report do not use containers, pallets, box-pallets or other such loading gear for throughout conveyance of part loads from door-to-door. Information received as to the handling of this equipment in goods sheds, does not give rise to the drawing of any conclusion.

PART II.

What are the best conditions of use of containers for small miscellaneous traffic (dimensions of the containers, conditions of ownership, tariffs)?

Containers as meant here are not in use with any of the Administrations questioned.

PART III.

What are the packing types to be recommended?

For the railways, the three main aspects of packing are :

1) the protection of the goods from damage;

2) the influence on the handability;

3) the influence on the utilization of space.

All Administrations have in some way or other taken measures which are of importance for the packing. They mainly lay stress on the protection of the goods in connection with the liability of the railways (the aspects above mentioned under 2 and 3 only come forward incidentally) and have a bearing on the packing itself, to the liability of the carrier and to the tariffs.

There are two systems of packing-regulations :

1) detailed prescriptions as to construction and material of the packing for the various kinds of goods;

2) a general prescription to the effect that the packing must afford efficient and suitable protection to the merchandise for transit by rail; in this case the railway in principle leaves traders to their own method of packing but reserves the right to decide whether or not the packing meets the requirements.

As a rule, the regulations are being respected. Administrations give suitable guidance to traders who show lack of appreciation of the importance of correct packing.

The packing is usually checked by the accepting staff. These checks are in some cases supplemented periodically by specially appointed inspectors. Packing is also judged by the employees responsible for dealing with claims for damage; most Administrations appear to experience no difficulties in getting staff with an expert knowledge of the intricate problem of packing.

In the case of goods not packed according to regulations or with an inherent risk of damage, the traffic is as a rule not accepted for conveyance at railway risk and the railway is relieved of its responsibility for damage.

In some cases there is a possibility left for conveyance at railway risk of unpacked goods which are readily susceptible to damage, upon payment of a surcharge to the normal rates. The railway thus receives a premium for the extra risk taken.

Some Administrations have made provisions for special reduced rates when goods are carried in certain approved types of packing. This is rational as this packing decreases the risk of the railway. The use of better packing is stimulated by this procedure.

A special class form the reduced rates for returned empties which exist with most Administrations. With a view to packing these have only sense in as far as they lead to the use of better packing. If this is not the case, then they can only be justified by motives as to encourage the use of railservice, conservation of materials, etc. Most Administrations do not consider these reductions justified technically from the point of view of cost to the railway. As a grave objection against these tariffs it may be raised that in times of inflated value of packing they may stimulate the re-use of packing which in fact is not suitable for repeated use.

The type of packing normally used by consigners, in general appears to be satisfactory. Too great an expansion of the use of fibreboard-packing should be avoided.

Some Administrations control by means of shock-recorders handling, shunting and the transport itself. This control is also important for the investigation as regards the soundness and the means to improve packing, at which several Administrations co-operate in some way or other with organisations carrying out researches into packing on a scientific basis.

Packing is a matter of cost for the consigner and consequently an element in competition. It is in the railways' interest to render information and assistance to their clients at the development of packing in order to get a sufficient protection at lowest cost. In this connection, consideration should also be given to the way of stowing.

[621 .132 .8 (43) & 621 .433 (43)]

Locomotives using high calorific value synthetic gas (« rich gas »),

by Dr. Meineke, Eng.

Professor at the Technical University, Berlin.

(Glasers Annalen, March 1950.)

I. High calorific value synthetic gas (« rich gas ») and its use as fuel on locomotives.

The combustion of raw coal on the grate of a locomotive is in fact a waste of mineral wealth because more is used than is necessary, and because valuable matter such as tar is destroyed uselessly. Lignite itself cannot be used for traction purposes : actually, firing locomotives with pulverized lignite has shown that its use is neither practical nor economical. At a Conference given on the 19th January 1949, at the « Deutsche Maschinentechnische Gesellschaft » (1), Professor Drawe called the attention of his listeners to a new fuel : « *rich gas* ».

Let us recall briefly that « rich gas » is obtained by the gasification under pressure of oxygen combined with the synthesis of average petrol under a pressure of 20 to 25 kg/cm² (284 to 355 lbs per squ. inch). It consists of 84 % of methane containing only 10 % of inert products (nitrogen and carbon dioxide), the remainder being combustible gas such as hydrogen, carbon monoxide and heavy hydrocarbons. It weighs 0.8 kg/m³ at atmospheric pressure and has a lower calorific value of H_u = 7 500 kcal, or 9 400 kcal/kg.

The « rich gas » is distributed through a network of mains such as those now in use in the Ruhr after compression in the ratio of 17.5 to 1, i.e. to a pressure of 350 kg/cm² (4 978 lbs per sq. inch) and can be supplied to the users at a price of 0.10 D. M. per nominal cubic metre. (All the prices given are pre-war.) The locomotive is driven by an explosion motor which, at a theoretical efficiency of 29 %, uses per hour 632 : 0.29 = 2 180 kcal, i.e. 0.23 kg/HP-h or 0.29 m³/HP-h at the motor shaft, which corresponds to the energy indicated in HP/h in a steam locomotive. The consumption of calories by a modern locomotive at the most favourable speed is 4 700 in the cylinders, that is to say with a boiler efficiency of 0.68 about 7 000 on the grate, which represents with coal of a lower heat value of 7 000 kcal a consumption of 1 kg per HP/h. This figure like that of 0.23 kg/HP-h for the « rich gas » motor is the optimum value. The ratio of the consumption of heat ought to be therefore 2 180/7 000 = 1/3,1 but this is not so as from figures collected in America 1 kg of gas oil gives the same power as 3.8 kg of fuel oil in passenger train service, 4.3 kg in goods service and 11.7 kg in shunting service. Geiger (1) points out from Russian statistics that the steam locomotive uses six times more coal and four times as much fuel oil [1] for the same tractive effort developed as the Diesel electric locomotive uses of gas oil. As the heat values of the two oils are alike, an explanation of the additional consumption of about 4 to 3.2, i. e. 1.25 remains to be given.

Whereas the « rich gas » locomotive has been designed (Chapter III) so that there are practically no sources of leakage, which are very considerable in steam locomotives. The steam consumption has to be increased

(1) *Glasers Annalen*, 1949, No. 5, p. 80.

(1) *Organ*, 1931, p. 172.

because amongst other reasons stable working conditions are reached only at the end of a considerable time. This is the reason why steam consumption measurements are commenced only after some 30 to 40 minutes after the start. When steam is shut off, the cylinders cool down and this loss of heat has to be made good when the regulator is opened again. Large heat losses result in the boiler from radiation (when steam is not drawn off the efficiency of the boiler is nil) and by using coal when standing spare. The particularly unfavourable conditions of combustion when the fire is banked down may be mentioned here. When standing spare, the fuel oil is cut off and the heat used is drawn from the incandescent firebrick lining. Other losses of heat occur when making up the fire, cleaning, washing out the boiler, steam leaks, and safety valves blowing. The losses are particularly serious in shunting service as the American figures shown. In these comparative figures, we have been dealing with oil fired locomotives. We make our comparisons however with coal, and the Americans have given the following ratios for coal as to oil 2.5, 1.84, 1.48 and the Russians 1.5. With their small cylinders the American locomotives use much steam. The variations in the figures are due to the great differences in the heat losses. If we take as a mean 1.6 the ratio of the calorific value of the two fuels can be taken as equal to 1.4; so that there is a further supplementary consumption of heat of $1.6 : 1.4 = 1.15$.

In these conditions, the ratio of the heat consumption should be $1.15 \times 1.25 \times 3.2 = 4.6$ which agrees with Prof. DRAWE according to whom 8 kg of coal of 7 000 kcal gives the same amount of power as 12 000 kcal of « rich gas ». The ratio of the heat consumption according to these indications is $\frac{12\,000}{8 \times 7\,000} = \frac{1}{4.6}$.

The hourly consumption of the « rich gas » locomotive of 1 000 HP is $1\,000 \times 0.23 = 230$ kg or 290 m³ costing 29 D. M. The 1 000 HP steam locomotive uses per hour $1.3 \times 1 \times 1\,000 = 1\,300$ kg of coal which at pre-war rates of 30 D. M./t would have cost 39 D. M. to which should be added the cost of water. The « rich gas » locomotive consequently saves 10 D. M. per 1 000 HP or about 26 .

We have to add to the cost of fuel the costs of repairs and capital charges, about an equal amount. The latter in absolute value is higher than for steam locomotives but is however made good as with Diesel and electric locomotives and electric units, by the work done in gross trailing tonne-kilometre (tkm), as these locomotives can remain in service without lengthy interruptions. In this regard too, we may here call attention to their very simple and little troublesome construction (Chapter III). For the same reason, the costs of repairs will not be higher than for steam locomotives, as the considerable expenditure on boiler repairs are eliminated. Based on the experience with Diesel locomotives in America, we can say that the expenditure under these two headings will not reduce to any extent the savings obtained on fuels.

II. Types of locomotives using « rich gas ».

The whole of the types of large Diesel locomotives has been developed and built for the first time in Germany :

1 Electric transmission [1] : 1923 for Russia;

2. Gear drive : 1925 for Russia;

3. Compressed air transmission [2] 1929;

4. Hydraulic transmission [3] : 1937, Reichsbahn;

5 Direct drive [4] : 1933, Reichsbahn.

All these remained as prototypes, as we had no suitable fuel. We were led to these investigations by the problem itself and by the hope of building for export. To-day, the position is reversed as we have the fuel and must create suitable locomotives. To

begin by getting out a prototype would be a waste of effort. The types corresponding to the characteristics of the « rich gas » motor must be perfected systematically and starting from this point many variants can be produced incorporating the minimum number of different details.

We have selected as the fundamental type of locomotive one with 5 pairs of wheels driven by a 1 200 HP, V motor of 8 cylinders with *Föttinger* hydraulic transmission and with three speed gear box, with variants B, C, D and E. By coupling two of these locomotives together we get a 2 400 HP locomotive driven by one man and which is powerful enough for present needs and even for future. In case of need, three units can be coupled together to give 3 600 HP, driven by one man (see fig. 1 and table). The 1 200 HP locomotive is the one which best fits traffic needs in Germany as we shall see later on. In addition a 600 HP shunting locomotive is needed, the steam engines being especially at a disadvantage in shunting service as we have already stated in chapter I. This smaller engine has 4 cylinders, which are identical with those of the 8 cylindered engine. It will be useful to start with to adopt the small 6 wheeled locomotive (type G, fig. 2) as an experimental one. From this type can be evolved also 1 B, type F locomotives, which can be coupled to the types D and E units to get 1 800 HP, which can be most useful, especially in goods working.

All the gear boxes are 3 speeds and have two gear ratios I and II relatively to the jack shaft. Each basic type is developed as two variants : speed and power. In this way, with one engine and one gear box (two models outwardly the same) in conjunction with three different driving wheel diameters coupled or not, we get 12 dif-

TABLE OF FIGURES.

Type	Wheel arrangement	Power of motor HP	Diameter driving wheels mm	Tractive effort Z_I kg	Weight		$\frac{Z_I}{Gr}$	V_{III}	Maxim. speed km/h	Driving wheel maximum r.p.m.
					in working order t	Adhesive weight Gr t				
B I	2B1	1 200	1 870	9 650	84	40	240	116	120	332
B II				11 200			280	96	100	260
C I	1C1	1 200	1 400	12 900	82	54	240	87	90	344
C II				15 500			287	73	75	305
D I	1D	1 200	1 250	14 500	82	66	220	77.5	70	300
E II	E	1 200	1 250	17 400	80	80	218	64.5	60	270
F I	1B	600	1 250	7 250	46	32	226	77.5	70	300
F II				8 700			270	64.5	60	270
G II	C	600	1 100	9 900	48	48	205	57	55	266

Z_I and V_{III} correspond to a horse power of 1 200 at the engine crank shaft and a transmission efficiency of 1.0 V_{III} is the rate of working in third speed when the motor is making 660 r.p.m.

ferent models which are not all needed. The wheel diameters are 1 250 mm (4′ 1 1/4″) for the type D and E goods locomotives, 1 400 mm (4′ 7 1/8″) for the type C mixed traffic locomotive and 1 870 mm (6′ 1 5/8″) for the fast locomotive of type B. As the standard diameters 1 750 mm (5′ 8 5/8″) and 2 000 mm (6′ 6 3/4″) cannot be used, 1 870 mm was adopted, a usual size in Bavaria and lying between 1 750 mm and 2 000 mm. The type A locomotive (2 A 2) has not been shown as this express train locomotive is of no interest

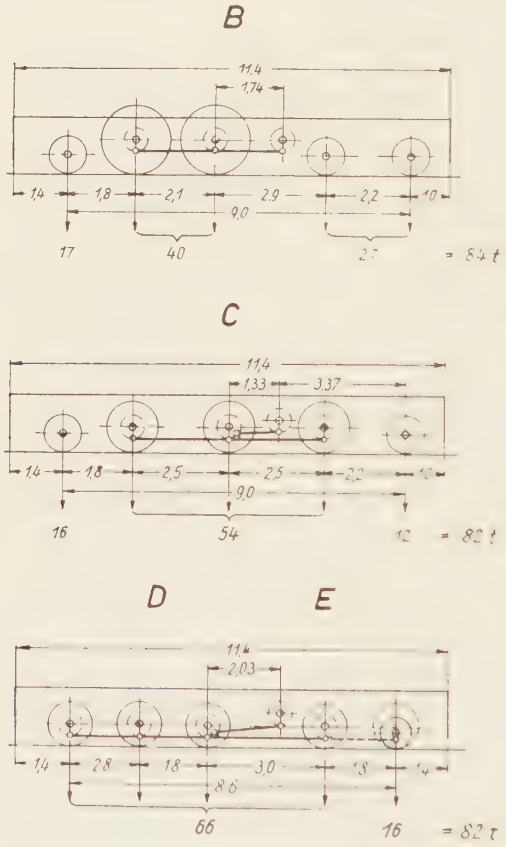


Fig. 1. — Basic types of the « rich gas » locomotive. Type E differs from type D in that the carrying wheel is replaced by a coupled wheel. The principal dimensions are given in the numerical table.

at the present time. When coupled in pairs, it would correspond with the 0.5 class. It would be fitted without alteration to the superstructure with a very high ratio gear box and its 1 850 mm (6′ 0 7/8″) wheels at 175 km/h (108 m. p. h.) would revolve at the rate of 480 revs per minute. If the axleboxes could be located exactly by means of adjustable wedges on both sides of each box and if the coupling rods could have roller bearings, it is probable such a speed could be maintained.

The B 1 is very well suited to haul light expresses; when coupled as 2 B 1, it forms the most important express locomotive able to replace classes 01 and 03. The B II type is suitable for light stopping trains and will often replace the 38 class. The 2 B II type, like the 2 B I, is used on important lines with heavy gradients; it replaces the classes 39 and 41.

The universal C type replaces the P 8 and T 18 types perfectly. The 2 C II type will do the work done by the 43, 44 and 45 classes. The C 11 can even be used to haul the goods trains in the level country replacing the different tank engines of 1 C 1 type. The D I type corresponds to the series G 8, G 8² and T 14 classes and can often replace the 50 class. When coupled in pairs, it is used like the 2 × 4 4 Bavarian locomotive or the T 20, as a banker on mountain lines.

The E II type does the work of the G 10 and T 16 classes and when coupled in pairs can be used like the 2 D I's.

As a 600 HP shunting locomotive is needed, it was tempting to make two other types, the F I and F II which are not used alone but coupled to a type D or E (Fig. 2). The air compressor is not fitted nor an accumulator. Furthermore a heating boiler is not needed as the F type is used to haul goods trains only. The combination of F I with D I and F II with E II gives a power of 1 800 HP which amply corresponds with that of the 50, 52 and 42 classes. The D I-F I combination gives as high a tractive effort as the 2 C I, but at a lower speed and smaller axle load. The type F is not being used singly or

coupled as we have plenty of old light locomotives for light trains. With all these explosion motor locomotives, which are relatively costly, it must be arranged to build up high numbers of kilometres in order to reduce the cost per gross tkm. The G type has three axles for shunting services, of 1 100 mm (3′ 7 5/16″) diameter, and wheelbase of 3.40 m (11′ 1 7 8″), arranged without difficulty with the type F II, like which it has no heating boiler.

ing spring : the suspension spring slides on the axle box. As the guiding length that is to say the distance between the last coupled axle and the pivot centre is 6.20 m (20′ 4 1/8″) for a frame length of 9.40 m (30′ 10 1/8″), the locomotive has no tendency to hunt, the more so as no excess centrifugal force can set up this movement. In the case of the twin locomotives as on the 2 B, the side play of the rear carrying axle can be suppressed.

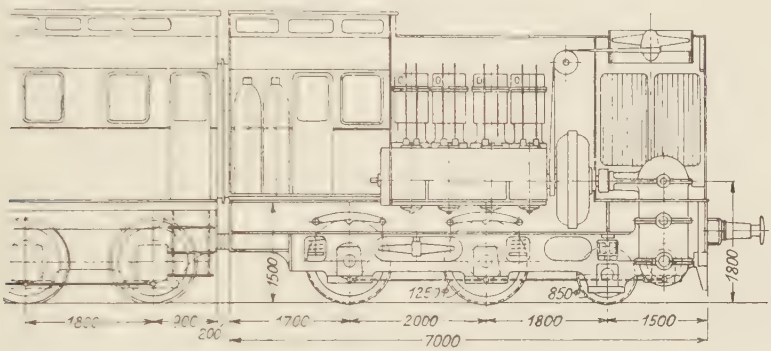


Fig. 2. — Type F coupled to a type D.

Principal dimensions. — Cylinders : bore : 360 mm. — Stroke : 400 mm. — Power of motor : 600 HP. — Speed of motor : 440-660 r.p.m. — Diameter of driving wheels : 1 250 mm. — Max. speed : 70 km/h. — Gas carried : 2.4 m³. — Weight empty about : 45 t. — Weight in working order about : 46 t. — Adhesive weight about : 32 t.

On the carrying axles two springs grouped in a single buckle. — Above the driving axles : shackles. — Equaliser forming spring. — 12 gas bottles upright. — 2 bottles 5 m arranged along the side.

As regards stability when in motion, it must be pointed out that locomotives operated in pairs coupled together at the inner ends thereby become « coupled frames » and consequently take curves well and have great stability when running. The B I and B II locomotives have been fitted at the rear end with a *Beugniot* lever in order to get two axle guiding even in backwards running. In the locomotives coupled together in pairs, the carrying axles are fixed, as their flanges do not contact the rails. The C type has a leading truck of the *Helmholtz* pattern. The trailing carrying axle has a load of 16 t and has some side play; it is fitted with a strong centralis-

In the type D the last coupled axle has side play and has a centring spring as the C type : the carrying axle is guided by the *Busse* device owing to lack of room for an articulated coupling rod. The E type differs from the D type only in that the carrying axle has been replaced by a coupled axle arranged like the trailing carrying axle of the D type. The guiding length is 4.80 m (15′ 9″), which is enough for a speed of 60 km (37 miles)/h. The axles of the F and G types have no play; their wheelbases are 3.80 m (12′ 5 5/8″) and 3.40 m (11′ 1 7/8″) respectively. The carrying axle of the F type may be given 10 mm (25/64″) side play with a centralis-

ing spring so as to avoid violent shocks occurring at the maximum speed of 70 km (43 miles) /h.

The use of a 4 cylinder engine on a locomotive must raise some difficulties through the uncontrolled inertia forces as the secondary forces are not balanced. At 660 revs, vibrations are set up in the locomotive at a frequency of 22 periods; their amplitude, which is independent of the speed of rotation, reaches 0.75 mm (0.0294 inch). They are very trying for the staff and tend to loosen all the fastenings. They can be cut by means of two counterbalanced weights revolving in the reverse direction at twice the speed. In motorcar design, they have been cured by carrying the engine on rubber pads. As this remedy cannot be adopted, the counterbalance weights should be fitted, which however is rarely done owing to the difficulty of fitting them. As shown in Fig. 3, one of the counterbalance weights revolves round the cam shaft but in the same direction because both are driven through toothed gears. The other counterbalance weight is driven by a 1″ chain at a maximum speed of 7.90 m/sec, which is permissible as there is only the low resistance of the roller bearings to be overcome. The centrifugal forces reach a maximum of 7 400 kg.

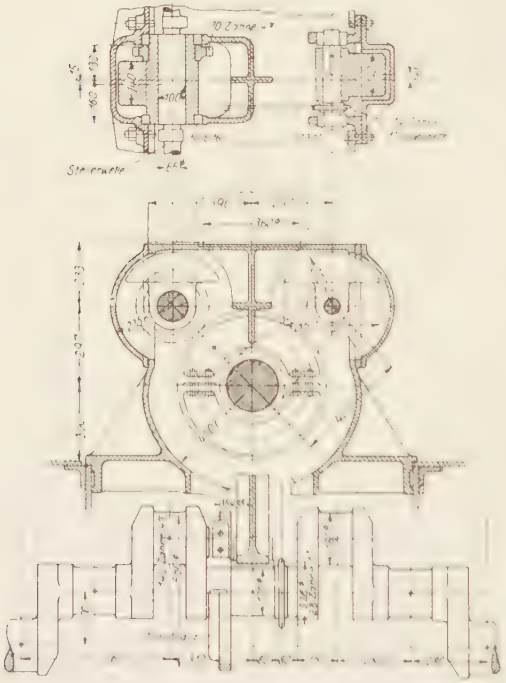


Fig. 3. — Counterbalanced weight of 4 cylinder engine.

Note. — Steuerwelle = cam shaft. — Zähne = teeth. — Rollenkette = Galle chain. — Kunstharz = synthetic resin.

The tractive effort Z_I shown on the table has been calculated from the power of the engine measured at the crank shaft with a theoretical transmission efficiency of $\eta_m = 1$. As will be shown in chapter III this efficiency will be 0.9. The tractive effort at the wheel tread will therefore be $Z_r = 0.9\ Z_I$ and the adhesive weight fully used (220 to 250 kg/t): it must be kept in mind that the tractive effort is completely uniform. The E and G shunting engines only use the 185 kg/t because with these locomotives wheel slip would be very disturbing. The speed V_{III} corresponds to $\eta_m = 1.0$ and a speed of rotation of the motor shaft of 660 r.p.m. At the maximum speed of travel the latter may reach 700.

To sum up, we see that with 2 engines, the cylinders and control of which are identical, 2 transmissions (each with two variants) and 4 driving wheel diameters, we have designed 6 base types developing 600, 1 200, 1 800 and 2 400 HP and giving speeds of 120 tot 55 km (75 to 34 miles) /h. By a combination of these types, we get a total of 15 variants. The advantages of this standardisation more than compensate for the drawback that two locomotives each of 1 200 HP are heavier than a single 2 400 HP machine. So high a power however cannot be installed in the restricted space due to the loading gauge, except at the price of great difficulty as regards construction which would have its repercussions on the working.

III. The type C « rich gas » locomotive.

The method of transmitting the power determines the general layout as well as the power. When it is a question of prototypes or single units the electric transmission is the most convenient because it consists of existing details. It is however heavy and costly, and its efficiency is not satisfactory. The hydraulic transmissions although lighter and cheaper are not more efficient. To get 1 100 HP at the wheel tread requires 1 300 HP at the motor crank shaft. A bad efficiency not only requires a larger engine and a greater fuel consumption, but also a greater dissipation of heat from the engine and transmission and so needs a larger radiator. Great importance must therefore be given to getting high efficiency.

A transmission by gearing gives the highest efficiency for the minimum weight and lowest cost. Its major drawbacks are that it does not give a continuously variable tractive effort in terms of the speed, and in the case of rail vehicles there is not absolute rigidity between the engine and the rail. This does not arise with road vehicles on which the pneumatic tyres, which have some circumferential elasticity, damp out the shocks from the engine (play in bearings, hammering) or when changing speeds. This is why the Diesel locomotive with mechanical drive mentioned in the second rank in chapter II has not given satisfaction, as well as the reason why gear drives are not used in railway working for powers exceeding 250 HP. This shows it is not wise in locomotive design to be tied down to one solution: on the one hand, the gears with friction clutch give too harsh a drive and on the other the hydraulic drive means heavy loss of power and cost much money. For example the hydraulic transmission of the I C I Diesel locomotive series V 16 is 3.70 m (12′ 1 5/8″) long and its maximum efficiency is only 85 %. The drive adopted for the « rich gas » locomotive is 1.90 m (6′ 2 7/8″) long and its efficiency reaches 95 %. A happy combination giving a sweet drive with little loss is to use a *Föttinger* hydraulic coupling [5] with gears as has been done recently in road vehicles and railcars.

The steps in the speed-tractive effort diagram (Z-V) are filled in by varying the admission of gas in the limits of the ratio of the speeds of rotation of 1 to 1.5 so that its speed remains constant. In this way, we get the diagram of the tractive efforts in terms of the speed (fig. 4), which resemble that of a steam locomotive. With a three speed gear drive giving a maximum speed of $V_{max} = 1$, the limit of adhesion is reached with 0.29 V_{max}. The coupling has an efficiency of 95.8 % at 440 revs per min. The admission of gas is cut down until the engine runs at 660 r.p.m. at 0.48 V_{max} when the coupling has an efficiency of 98.75 %. This is repeated with the second speed gear with 0.655 V_{max} and the third with 1.0 V_{max}. Consequently, the shunting engine of type G can in the first gear exercise the maximum tractive effort up to V = 16 and do all shunting work in first

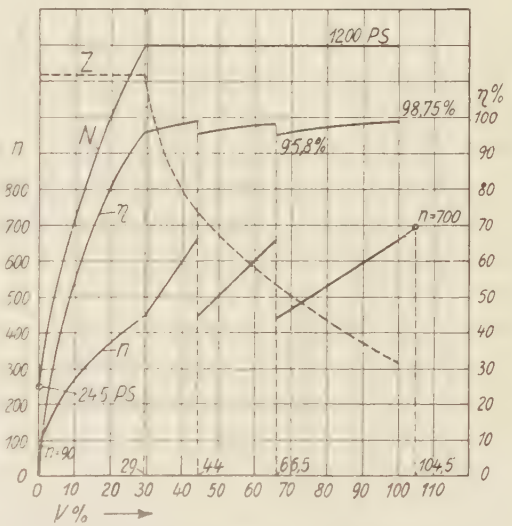


Fig. 4. — Tractive effort — speed diagram.

V = speed. — N = shaft horse power of the engine. — n = speed of rotation revs per min. — η = efficiency of the transmission. — At starting (V = 0), the speed of the engine falls to 90 revs and the power to 245 HP.

gear up to V = 24. The handling of the locomotive therefore is as convenient as with electric or hydraulic transmissions. The whole of the 1 200 HP locomotives are identical above the frame including the transmission. The type C locomotive is shown in figs. 5 and 6 because it can be used most frequently and because other types have been based upon it.

steady between 440 and 660 r. p m. When $\eta = 660$, the average mean specific pressure is 5.1 kg/cm² (71.16 lbs per sq. inch). It would be possible to increase the pressure much above 5.1 kg/cm² at 660 r. p. m. but it would then be necessary to exhaust under constant load much greater quantities of heat from the radiators, cylinders and bearings. The temperatures of the

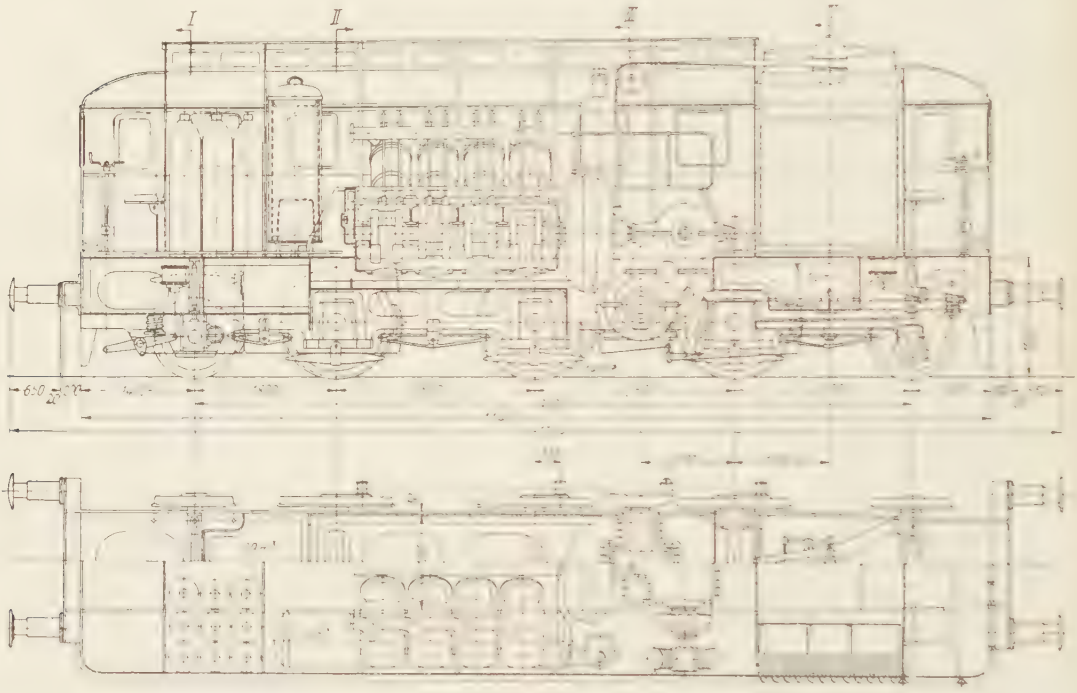


Fig. 5. — Type C « rich gas » locomotive.

The Otto 4 cycle explosion motor used has 8 cylinders in V because this form has many advantages : light and compact, masses perfectly balanced, and the simplest crank shaft. The cylinders are 360 mm (1' 2 3/16") diameter by 400 mm (1' 3 3/4") stroke and develop 1 200 shaft HP at 440 r. p m. The average mean specific pressure on the piston is 7.8 kg/cm² (110.94 lbs per sq. inch). The motor speed is regulated by a centrifugal governor acting on the gas and air supply so that its power remains

cylinder walls and the bearings limit the power of each motor. This is why the best solution is to limit them to a predetermined value but to make full use of it. This speed of 440 to 660 r. p. m. is relatively slow and this reduces repair costs. The dimensions of the motor are such that it can just be got inside the loading gauge I. Its weight has been reduced by making it a V engine; actually its length is only 2.70 m (8' 10 1/4") as compared with 3.20 m (10' 6") for the V 16.

To regulate the power a centrifugal regulator is fitted which, at full power, only cuts off the incoming rich gas without affecting the air so that there is no marked drop in pressure in the suction with the losses this means, and the compression remains high. It is only when the power under full load is reduced that the air is reduced. This useful regulation is made possible by the fact that methane burns between wide limits. We would refer on this subject to Dr. DRAWE's article and to fig. 4 published in No. 5, 1949, p. 83 of the « Glazers Annalen ». The driver can move in the direction to reduce power the pivot of the lever which transmits the position of the regulator sleeve to the throttle valve. The driver regulates it to get the power needed and the regulator takes care it is. If a twin locomotive has only to develop less than half its normal power, the rear engine is shut down entirely as it is better to operate with one engine at full power than with two at half power.

An explosion motor is extremely easily started up if the system shown in fig. 7 is used; it was formerly used on road vehicles. All that is needed is to turn over the crank shaft a few times in the morning and the engine starts up perfectly even after a long stop as soon as switched on. This was very convenient when there were no electric starters. The method was given up as it uses too much current from the battery and because the contacts had to be attended to from time to time. In the case of locomotives, these drawbacks are not serious because there is a driver in charge of the machine and the consumption of current is not so important as on a road vehicle. The petrol motor had to be turned over a number of turns each morning

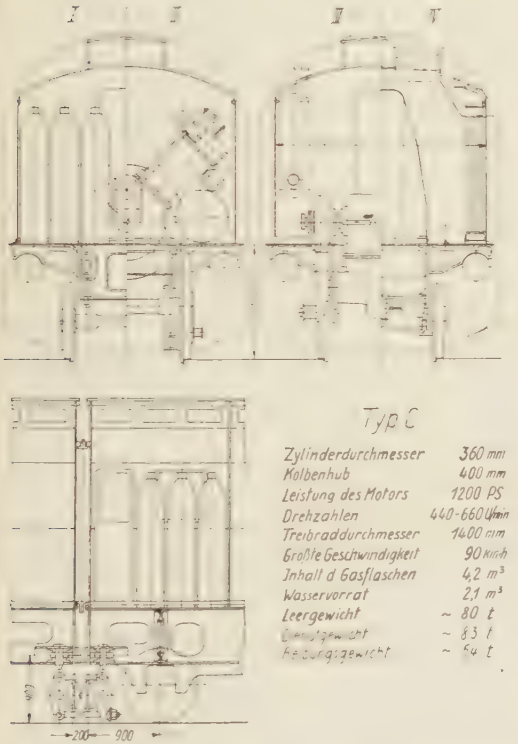


Fig. 6. — Longitudinal sections corresponding to figure 5. Below, on the left, longitudinal section by the ends of the two coupled elements.

Translation of the legend:

Type C.

Bore: 360 mm.
Stroke: 400 mm.
Power of the engine: 1 200 HP.
Speed: 440-660 r.p.m.
Diamet. of driv. wheels: 1 400 mm.
Maxim. speed: 90 km/h.
Capacity of gas bottles: 4.2 m³.
Volume of water carried: 2.1 m³.
Weight empty: about 80 t.
Weight in working order: about 83 t.
Adhesive weight: about 54 t.

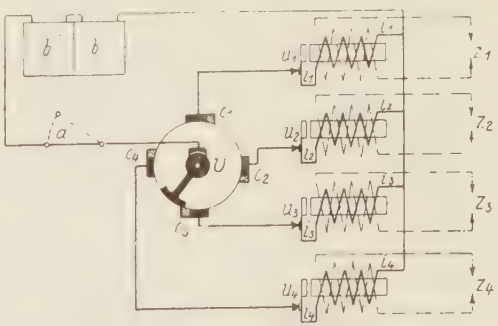


Fig. 7. — Ignition layout.

(From: von LÖW « Das Automobil » (*The Automobile*), 5th edition, *Kreidel*, 1924, p. 215.) By lengthening the contacts c1 to c4, the piston brings the crank pin into a satisfactory position for starting.

because during the night the mixture of air and petrol had become disassociated. « Rich gas » however retains its inflammability and this is why the motor will start even after a long stop. If thought necessary a starting engine can be located at the left side of the rear end of the main engine. This is a single cylinder two stroke engine of 400 cm³ cylinder volume (bore 80 mm = 3 5/32″, stroke 80 mm) with internally tooth reduction gear of 1 to 2.5 reduction. A shaft connects it to the casing of the *Föttinger* coupling, upon which a friction disc bears giving a reduction of 1 : 20 (total reduction 1 : 50). Due to the adhesion, it consequently bears against the coupling like a wedge and disengages as soon as the main engine starts. The « rich gas » locomotive has a number of other devices of such kind, which though rather unusual, have none the less passed their tests; they would have had little interest had they been made up in small numbers only. In this case however we are dealing with a large number of pieces, as all the types of locomotives have to be fitted with them. All these small special assemblies play their part in ensuring a simple and cheap engine, the objective of the whole of this study.

The *Föttinger* coupling, 1 500 mm (4′ 11 1/16″) outside diameter is very large, because the motor runs at a low speed and a reduction gear would not fit in with the above directing idea. Between the power N HP of the motor, its speed of rotation n_1, the speed of rotation of the secondary shaft n_2 (rev./min) and the inside diameter D_m there is a relation $N = C \left(1 - \frac{n_2}{n_1}\right) \left(\frac{n_1}{100}\right)^3 . D_m{}^5$. When filled with fluid oil, (4 to 6° Engler at 50° C.), the value of C is about 63. Its efficiency is η , as the speed of rotation does not vary. By using this value and taking N = 1 200 and D_m = 1.47, the individual efficiencies in the traction effort/speed diagram Z-V of fig. 4 have been calculated. The coupling is secured by a flange at the end of the motor shaft.

The gear box which follows is connected to it by a coupling with some flexibility in order to take up small displacements. It is fastened to the frame of the locomotive at three points; to the bearings of the jack shaft and to the back bearing of the bevel wheel. As a whole, its construction is the same as that of the mechanical drive locomotive mentioned in Chapter II, under number 2. The shaft of the bevel pinion, the axis of which coincides with that of the crank shaft, carries a bevel pinion which is in mesh with two other bevel wheels of the same diameter for forward and backward running. They are coupled as desired by means of dogs to the cross shaft at the ends of which are two magnetic friction clutches. These drive the two hollow axles of the gear wheels of the 2nd and 3rd speeds. The cross shaft carries the small gear wheel of the 1st speed which does not need a friction coupling because the corresponding large wheel on the intermediate shaft incorporates a free wheel. This method using a free wheel requires a special layout as it has to act in both directions of rotation. The change gear is simple but the description of all these particular features would take too long. The intermediate shaft has 4 gear wheels, one for each of the three speeds and one for the drive to the jack shaft with the cranks at the outer ends. This last is done with gears of 17 : 34 or 15 : 36 teeth respectively, according as it is a question of a variant of speed or force of a given type (variants I and II). The number of teeth are moreover : bevel wheels : 24 : 24; first speed : 19 : 43; second speed : 24 : 36; third speed : 31 : 31. The total reductions are therefore

	I	II
Third speed . . .	1 : 2.00	1 : 2.40
Second speed . .	1 : 2.96	1 : 3.55
First speed . . .	1 : 4.52	1 : 5.42

The dogs of the bevel pinions for changing direction remain engaged until the locomotive is reversed. When in second and third speeds, the engine can also be used for braking. All shafts run on roller bearings. The transmission of the power is through three stages of gearing : if as is usual the loss in each stage is taken at 1 %, the efficiency of the whole is 97 %.

In the Russian geared locomotives, in third gear a kind of loss of ventilation took place in the third gear in the friction couplings of the first and second gears running idle and which, under such conditions, revolved at double and four times the normal speed. This appreciable reduction of the efficiency does not happen with the locomotives we are describing because the coupling of the second speed only revolves at one and a half time its normal speed, and the first speed has no coupling.

The mean efficiency combined with that of the *Föttinger* coupling is 95 %. The fan takes on the average 34 HP , the air compressor 1.5 and the dynamo 2.5; a total of 38 HP. which are taken from the transverse shaft or from the casing of the coupling directly or by belt. After deducting this 3 % of the power, we get an efficiency of 92 % at the crank pins. If the friction in the bearings be taken as 1.8 kg/t we get for an adhesive weight of 54 tons a loss of 100 kg or on second speed 1.5 % to which can be added 1 % for the coupling rod bearings. In this way we get the ratio of 0.897 between the power at the motor crank shaft and tyre.

The radiator is fitted in accordance with present day practice. Vertical revolving shutters adjusted by hand guide the current of air towards the centre line of the machine. This work of deviation and acceleration falls on the main engine by the increased resistance but causes smaller losses than a fan would involve, as the efficiency of such fans is low. To reduce the volume of air (in winter), shutters in the air duct are used. By moving these shutters, part of the air does not pass through the radiator, and this helps the fan. The fan is driven by the coupling casing by a belt passing over two guiding pulleys, one of which can be used to adjust the tension of the belt. The belt is fairly long and flexible so as to follow sudden alterations in the speed of the « rich gas » engine when changing speed, in spite of the high moment of inertia of the fan. The quantity of air given varies as the square of its speed of rotation, in other words in the ratio of 1 to 2.25. Fluctuations in the cooling effect are compensated by the fact that on leaving the radiator the water passes through coils in the water tank for the steam heating.

This reservoir, containing 2.1 m^3 (74.16 cubic feet) of water, makes a large heat storage tank. The cooling tubes need not have a great surface area : actually as they are wetted on both faces by the water, the transfer of heat is excellent. In the cold weather when the heating is in use, the fan needs only revolve slowly : the cooling coil is then cut out. When the main engine is stopped cooling by air stops, but the cooling water pump continues to work and ensures there is equilibrium as between the temperatures in the circuit. Automatic regulation of the cooling water temperature was not considered needed, but this task has been left to the driver, who looks after the radiator as on the steam locomotive, the thermodynamic opposite, the boiler, is looked after by the fireman.

The left end of the transverse shaft drives through a Vee belt a slightly enlarged train lighting dynamo. When the speed falls to 400 r. p. m., it is automatically cut out by the 24 V accumulator battery, which supplies current for lighting and for the various small oil and cooling water pumps.

The right hand end of the transverse shaft drives the air compressor for the brake: it is a two cylinder V type air cooled. The masses are not balanced for the secondary forces but it is carried on india rubber like an automobile engine. It compresses about 4.9 l (1.1 gal.) of free air per

revolution to a pressure of 8 kg/cm² (113 lbs per sq. inch) in a very large reservoir of 1.3 m³ (45.9 cubic feet) capacity. This pressure is reached in about 2 100 strokes or in 5 minutes even when the transverse shaft is only running at 430 r. p. m. The quantity of air stored has to be large because the main engine, which drives the transverse shaft, ought not to be revolving when the locomotive is stationary at the head of the train for amongst others the brake test. The capacity of the compressor is high so that the air required can be restored quickly (its couple is about 1.1 % of that of the main engine). It runs light most of the time and it might have been better to have stopped it during all this time. But as there was no room for a friction clutch, it is coupled permanently, but with some elasticity, to the transverse shaft.

The compressor, the dynamo and fan control are special types developed with a view to simplification. They have saved the auxiliary engine with electric transmission which up to the present has had to be installed on all Diesel locomotives. Now this engine is a nuisance, takes up room, makes noise, and is expensive to buy and maintain.

The heating is by means of a vertical boiler heated by « rich gas » and by a reserve of 2.1 m³ (74.16 cubic feet) of water, in two tanks arranged between the longitudinal members of the frame. The heavy trains are hauled by double locomotives so that there are 4.2 m³ (148.32 cubic feet) of water, sufficient for 6 hours running.

For operating the locomotive, the control table in addition to the measuring devices has the following :

1) The regulator for controlling the power of the motor. It consists of a lever with a latch and a rack with three notches, which the latch can engage : full over; full opening; middle position; light running, third notch stop, the ignition being cut off. The position of the regulator is transmitted accurately to the gear operating the butterfly valves by means of what is known as the electric shaft [6].

2) A lever controller. Neutral : everything free. Position I : forwards running; one of the dog clutches of the bevel pinions is brought into position by an electric coil. The first speed is engaged without other operation. Position II : the magnetic clutch of the second speed is excited progressively as the magnetism does not act instantaneously (hysterisis). The free wheel of the first speed cuts out. Position III : the lever is brought to this position slowly so that through the action of the resistances, the magnetic field II progressively weakens whilst that of III builds up. For a brief moment, the two magnetic clutches are excited. The tractive effort is not cut out wholly [7]. From the neutral position to reverse running there is only a *single* position. Actually, when the direction of running has to be changed for a longish time, the driver goes to the other end of the locomotive. The change from third to second speed takes place slowly; on the contrary the change from third speed to neutral is quick so that the second speed may not be excited and act as a brake. Automatic change speed gear boxes were not used intentionally, such as those varying the speed with the running conditions, because they do not ensure the most economical working. For example, it is useful at light loads to be able to run at a very low speed of rotation whilst cutting down the admission of gas so that the motor works at a high mean pressure in the cylinder. It is possible to work like a steam locomotive with the regulator and cut off. A skilful driver soon finds the best working position and has greater pleasure in driving than when he becomes an automaton, who only has to set a lever and the running speed. On the switch board of the double locomotive, there is also a switch for cutting out all the circuits in the trailing locomotive, as is done when the engine of the latter is cut out at low power. The lay-out of the two units is

identical. The regulator as far as possible should never be put in the light running position but immediately into the stop position so as to save fuel and useless wear as the motor will restart immediately the lever is put into the intermediate position.

The question of choice between liquifaction and compression when transporting « rich gas » requires much reflexion. Natural gas (methane) has been used in Italy [8] [9] and in France [10], but only for small powers and short runs, so that the arrangements adopted could not be used as models. The considerable weight of the bottles of compressed gas is rather alarming, but liquifaction is costly and involves some troublesome features: the transfer from one container to another is difficult because ice forms on all parts coming in contact with the « rich gas », which is at a temperature of — 162° C. at least. It is also difficult to measure the quantity supplied as the « rich gas » is supplied at 350 kg/cm² (4 978 lbs per sq. inch) and as at 200 kg/cm² (2 845 lbs per sq. inch) it occupies a much smaller volume than that corresponding to this pressure, it seemed more rational to use it as a gas.

The first thing to do is to decide how much « rich gas » has to be carried to run the same distance as the water in the tender of the steam locomotive covers. The coal carried enables a double distance to be covered owing to the time lost is going to the shed to recoal, whereas water can be taken during station stops. The « rich gas » can be taken really more conveniently. To take water the fireman has to be on the tender whilst the water column is in use and frequently both men get wet. The gas main however can be connected by one man only as the valves are all grouped very close together. It is easy to calculate the number of hours a steam locomotive can work at the maximum boiler evaporation rate. On the Reichsbahn, the boiler is considered to be developing its maximum when giving D = 57 kg of steam per m² of heating surface exposed to the fire per hour. The quantity of water carried W is known. The quotient W : D gives the number of hours in question with all the additional duty and standing spare times required by traffic working taken into account. It varies between 2.2 and 2.8 or an average of 2.5; for tank engines it is about 1.4 hours. The full power developed by a « rich gas » locomotive being 1 200 HP, the quantity of gas carried should be sufficient for 2.5 × 1 200 = 3 000 HP-h. If the consumption of gas be taken as 0.25 instead of 0.23 kg/HP-h, 750 kg of « rich gas » has to be carried or at a specific weight of 0.8, a volume of 940 m³ (33 195 c. ft.) at atmospheric pressure. The reduction of volume of the « rich gas » at high pressure is not yet known. Adopting an unfavourable hypothesis in considering it as methane (γ = 0.714), the reduction of which at 200 kg/cm² (2 845 lbs per sq. inch) is 0.76, in other words equal to what it would be theoretically for a compression to 264 kg/cm² (3 754 lbs per sq. inch). The pressure of 200 kg/cm² is particularly favourable because the contraction diminishes above and below this value. If the temperature in the bottles be taken at 10° C., the volume is found to be

$$v = \frac{273 + 10}{273} \times \frac{750}{0.714.264} = 4.2 \text{ m}^3 \text{ for } \gamma = 196 \text{ kg/m}^3.$$

Eighteen standard bottles 368.9,5 in diameter, and 1.8 m (5' 10 7/8") long, valves excluded, holding 150 l (33 gallons) and weighing 192 kg (422 lbs). They are carried vertically at the rear end. In addition two other bottles are fitted horizontally under the footplate along each side. Each of these bottles is 9.6 m (31' 6") long, holds 750 l (164.98 gal.) and weighs 762 kg (1 680 lbs). In all the gas bottles weigh 18 × 192 + 2 × 762 = 4 900 kg (10 802 lbs) empty and 5 650 kg (12 456 lbs) full, valves and piping not included. This weight is in no way excessive for a 10 wheeled locomotive. It might be necessary to extend the radius of action of the loco-

motives working in pairs, the only ones that can be considered for use on long runs. In this case, a 4 wheeled tender is provided between the two units, with a frame 5.2 m (17′ 7/8″) long and a wheelbase of 3.6 m (11′ 9 3/4″). The pairs of locomotives would then be 28.14 m (92′ 3 7/8″) long with a total wheelbase of 25.4 m (83′ 4″), so that it could be handled on a 26 m (85′ 3 5/8″) turntable if it had to go into shed. The tender carries 35 gas bottles, 4.52 m (14′ 10″) long like those types. The 1 C 1 type V 16 [3] locomotive develops 1 400 HP when supercharged; this compensates for the loss through its inefficient transmission; its frame is 1.1 m (3′ 7 5/16″) longer than that of the B and E types. It weighs in working order 75 t. NEUMANN [11] gives for a 1 C 1 locomotive of the same type developing 1 250 HP a weight of 74 t. In view of these figures, a weight of 75 t can be taken as that of « rich gas » locomotive if the carburant were carried in liquid form. 5 t have to be

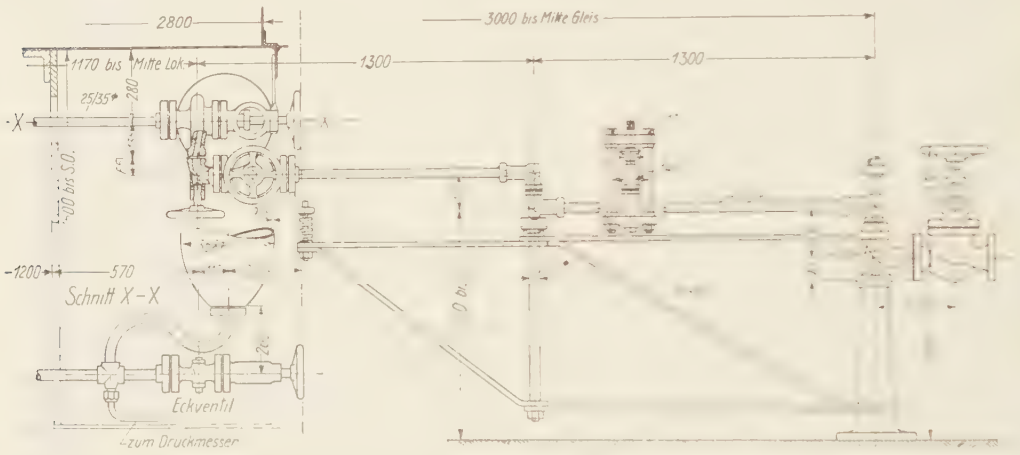


Fig. 8. — Layout for supplying gas to the locomotive. The articulated joint of the pipe is free. The end is fitted with a spring to enable it to be moved.

Explanation of the German terms:

Bis S. O. = down to rail level. — Bis Mitte Lok = to the centre line of the locomotive. — Bis Mitte Gleis = to the centre line of the track. — Schnitt X-X = section on X-X. — Zum Druckmesser = to the gauge. — Eckventil = angle valve.

on types F and G; the total weight thereof is 13.65 t and they hold 14.35 m³ (506.76 cubic feet) of gas. The quantity of gas on the double locomotive is in this way increased from 8.4 m³ (296.63 c. ft.) to 22.75 m³ (785.74 c. ft.) and the radius of action is multiplied by 2.7 times. It reaches 800 km (560 miles) in round figures, corresponding to 26 300 HP-h. The 35 bottles weigh 17 t full so that the weight of the tender does not exceed 28 t.

The weight of the locomotive has been arrived at from the existing analogous added for the gas bottles, and the weight of the water for heating by steam so that the C and D types will weigh in service 82 t and the E type (non-superheated) 80 t. If these specific weights of 68 kg HP be compared with those of comparable steam locomotives with separate tenders, we get 76 kg HP for the series 38 (P 8), 59 kg/HP for the 01 class and 78 for the class 84 tank engines.

We will now say something about the fixed installations for supplying the gas to the locomotives, an essential part of the

whole project. The « rich gas » is supplied from the mains at 350 kg/cm² (4 978 lbs per sq. inch) pressure, through a reducing valve which lowers the pressure to 200 kg/cm² into a storage tank which can be for example 9 long gas bottles, the same pattern as those on the sides of the locomotive holding 8.1 m³ (285 c. ft.) in all. From this store it passes through a 40 mm (1 37/64″) diameter pipe and a stop valve to feed the articulated feed pipes (fig. 8). The diameter of these is 25 mm (63/64″) so that they can be handled easily and the volume between the stop valve on the main and that on the locomotive is reduced as much as possible.

The lost space is only 1/4 l. The spherical seats are held against each other by means of set screws and Belleville springs so that they retain their pressure a long time. The 25 mm pipes have an area of 4.9 cm² and if the rate of flow of the gas be $w = 60$ m/sec, the 8.4 m³ bottles of the double locomotive can be filled in 4 minutes 48 seconds. The pressure during discharge is $\gamma \cdot \frac{w^2}{2g} = 0.196. \frac{60^2}{2g} = 36\,000$ mm of water = 3.6 kg/cm² to which has to be added the resistances to discharge. Towards the end of filling the locomotive bottles, the necessary drop of pressure may not be left, but to meet this, it is possible to work at a much higher gas speed. Furthermore the locomotives will never come into the depots with the bottles empty so that refuelling in the station will never take more than 5 minutes. If the pressure in the storage tank was raised to 210 or 220 kg/cm² (2 986.9 or 3 129.1 lbs per sq. inch), the time to take gas would be again shortened. It was not thought desirable to do this so that the bottles would not have to stand excessive pressure. The articulated pipes are 2.6 m long so they can cover a length of $2.6\sqrt{2} = 3.68$ m with articulated joints with 90° movement.

As regards the locomotive, the frame plates 30 mm (1 3/16″) thick are brought in at the leading end in order to give more space for the movement of the carrying axle. The *Helmholtz* truck is of the type described in *Die Lokomotive,* 1940, p. 73.

The brake has been divided into two independent systems, so that there is no brake gear under the main engine.

The part of the body over the engine room between the radiator and the rear driving compartment is jointed below the windows so that the upper part can be lifted clear with the roof. Stiffeners must be provided at the joints to prevent the roof giving. Roof ventilators must be provided so that amongst other reasons the « rich gas », which is light, can get away quickly. Below the windows, large panels have been fitted through which all parts in the angle below the engine cylinders are accessible.

Leaving aside all the mass of details to get back to the essential, we say that the « rich gas » motor has two important advantages : it uses a cheap national fuel; thanks to its easy lighting it can operate at varying pressure, for example by varying the proportion of the mixture so that the power remains constant for widely differing speeds of rotation. From this property derives the possibility of using a gear drive which gives the highest efficiency for a lower price and weight. The drawbacks of this transmission such as lack of flexibility and the break in the tractive effort when changing speed are avoided by using a *Föttinger* coupling and magnetic friction clutches during the change of gears. Furthermore the greatest simplicity in the installation and equipment is the result of suppressing the auxiliary engine. The whole involves the greatest care in designing the auxiliaries as here again care in the details guarantees success even if no new principles are being applied.

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NEW BOOKS AND PUBLICATIONS.

[385 (09 (42)]

Unification of British Railways. — Administrative principles and practice, by Members of the Railway Executive. With a preface by its Chairman, Mr. John ELLIOT, M. Inst. T. — 1951, Published by *Modern Transport Publishing Co. Ltd.*, Norman House, 105/109, Strand, London, W. C. 2 (Price : 2 s. 6 d.)

In 1923, the Railways Act was already a great step forward towards unification. All the separate railway undertakings of that period were amalgamated into four main Companies in addition to the London Passenger Transport Board. A new and more important step was taken by the nationalisation law of the Transport Act which came into force on the 1st January 1948. The latter, in addition to placing all the railways under a single authority, had at the same time a more comprehensive character as its title indicates, as it extends to all transport with a few given exceptions.

To the *Railway Executive* falls the heavy task of assuring the working of the unified system whilst endeavouring to attain the objectives quoted in the law. What are these objectives? This work gives first hand information about them.

Notes written by actual members of the Railway Executive, each dealing with the branch for which the author is responsible, are collected together in this work. All the main divisions of the railway are considered : the organisation of the operating department, the mechanical and electrical department, the permanent way and signalling, the supply department, commercial questions and staff administration.

It is above all the leading ideas, the methods to be applied, and the principles laid down which are stressed. It is conceivable that many of the measures applied cannot produce their full effects until some time has elapsed, owing to the nature of things. Others are temporarily altered owing to unfavourable circumstances. But after three years work only, substantial results have already been achieved. These are given in the various reports. Other questions still remain to be elucidated, but the organisations responsible for studying them and taking the necessary decisions have already been set up.

This first complete official report published to date on the activities of the Railway Executive makes it possible to judge of the size of the task assumed. Moreover its actions are not restricted to endeavouring to obtain simplications and the savings made possible by having all resources in common. Many of the reforms made or under consideration have as their object the modernisation of methods and equipment in general so as to increase the efficiency of the railway. For this reason the reader will find this book has a double signification.

E. M.

[625 .14 (01)]

VENKATARAMAYYA (V.), B. A., B. Sc. (Hons), A. M. I. E., Deputy Chief Controller (Civil), Central Standards Office for Railways. — **Stresses in Railway Track.** — One brochure (6 1/4 · 9 3 4 inches) of 35 pages, illustrated. — 1950, Published by the Ministry of Railways, Government of India, Delhi.

In India, rail sections are under revision and the Central Office for Railway Standardization is considering proposals to be set up on a rational basis. The author, who is engaged on part of this work, has the task of indicating the principal considerations which arise when it is desired to design a new type of rail.

Guidance has been sought in the theoretical and experimental research undertaken in India and especially in America.

As a starting point, the author examines the theory based on the hypothesis of a continuous member supported on an elastic foundation. In order to calculate the bending moment, this theory calls for a sinusoidal function subject to a diminishing exponential. The second derivative of this function gives the bending moment. The superposition of the stresses will give the moments due to various loads following each other at known intervals.

But these are only the static aspects of the problem and one of the causes of stress. In order to take into account the dynamic stresses, the author proposes a speed coefficient, calculated by means of a formula, worked out by the Indian subcommittee on bridges, which includes taking care of the effects of rolling. The effect called « hammer blow » due to the counterweights partly balancing the weight of the running gear which itself has an alternating effect on the stresses arising, the action of the steam and the inertia of the parts having an alternating motion, are analysed and illustrated diagrammatically. Other effects are considered to be covered by the speed coefficients referred to above. A diagram, reproduced from an earlier essay on the subject, provides another method of determining the effect due to adjacent axles.

The developments, which we have briefly referred to, are supported by calculation of the tensional stresses produced by the running over the track of a locomotive of the *Pacific* type. This calculation is carried out until the determination of the maximum moment which is to serve as a basis for consideration as well as the expansion and compression stresses resulting therefrom.

In his preamble, the author points out that in the results, which were obtained, certain gaps have appeared which it would be desirable to fill, but this would necessitate further extensive research. The continuation of the report includes an analysis of various accessory phenomena but which are not without importance.

As regards firstly, longitudinal bending, we have the inverse flexure due to concentration of the load, the contact tensions, the bending of the head of the rail due to elasticity of the web, friction between rails and sleepers, the tilt or inclined bedding of the rail and the conicity of the tyres. In other respects too, the actual intensity of the stresses applied is affected by the flexure of the rail. In this connection, the author examines the conclusions arrived at in the report by Messrs GELSON and BLACKWOOD, who made several thousand measurements under greatly varying conditions.

The rail is moreover subject to deformation due to eccentricity of the loading and to lateral thrust. Numerical calculations show the value of the stresses arising. Special note is made of stresses in the web and in the fillets at the neck of the flanges. A paragraph concerning fished joints concludes with recommendations as to the most suitable metal to be used for fishplates.

As regards tensional stresses in rails permissible in practice, the author gives figures which he considers should be applied, taking into account the quality of the metal and the frequency of stress variation according to their relative importance and sign. Finally general considerations regarding shape and dimensions of the three parts of the rail section and of the fishplates will be welcomed by the student.

Although it does not necessarily enter into the discussion, the resistance of the track to lateral displacement nevertheless calls for consideration. The author quotes practical results of experiments carried out fairly recently. He would like to see this research continued to cover a more extended field.

In conclusion we would emphasize the importance of directing the work definitely towards the determination of rules and coefficients capable of immediate and direct application.

E. M.

[656 (06]

Centenaire de l'Association des Ingénieurs sortis de l'Ecole de Liège (A. I. Lg.), Congrès 1947. Section Transports. — *Centenary of the Association of Engineering Graduates of Liege School) (A. I. Lg.), 1947 Congress. Transport Section.* — Volumes I and II respectively of 250 and 322 pages, copiously illustrated. — Liège, A. I. Lg., éditeur, quai Paul van Hoegaerden, 12.

The Association of Engineering Graduates of Liege Schools celebrated in 1947 the centenary of its foundation. As one of the Faculties of the University of Liege, the Engineering School has long had a reputation far beyond the Belgian frontiers.

Various celebrations in which the Higher Authorities and many famous scholars and engineers took part made of this anniversary an occasion worthy of this illustrious city. Amongst other things, there was a scientific Congress.

The organization of this congress was due to the praiseworthy initiative of the jubilee Association. It was an expressive way of stressing the role of the engineer in every day life after a hundred years activity. It gave the Engineers of Liege an opportunity to report on some of their most noteworthy achievements.

Open to all the engineers of the country and abroad, and covering most of the branches of applied science in industry, the congress had a universal and international character.

The most various subjects relating to the engineering field were dealt with in the reports presented to the congress. They covered mining, metallurgy, electricity, transport and civil engineering.

In the Transport Section, which is the one in which our main interest lies, the subjects dealt with were particularly numerous. The reports sent to Liege filled two volumes of 250 and 320 pages respectively, although the authors were not unduly long. Most of them on the contrary prepared very concise reports.

At the present time, however, transport in its various forms, some of which are still in their infançy, covers a very wide field. The Congress wished to accord it its dues and examine it under all its aspects.

The first volume includes all that which we might call transport on the ground : the railways, light railways, urban transport, road transport. The second covers waterways and maritime transport in the first place; the most recent techniques are the subject of separate chapters : air transport and various other forms of transport (fuel oils, gas, electricity).

Each report covers a special subject, for

example in the case of the railways, operating questions, the rolling stock, the permanent way, electric traction, safety, organization. In each chapter these are followed by a general report, giving a general idea of the group of transport being studied.

Three reports of a more general nature deal respectively with all the methods of transport which we mentioned, the development of railway electrification, and the evolution of aviation.

Three industrial monographs sum up very happily the activities of well-known Belgian firms; the two first famous for their contribution to the design and construction of railway rolling stock and the third for the place it occupies in maritime transport, especially that linking up Belgium and her Colony.

These two volumes contain much invaluable information. The Liege Engineering School must be congratulated on publishing them. They give a picture of the way the different methods of transport, both the oldest and the newest, have developed and are being perfected. The reader is given positive details on the characteristics of each one of them to enable him to form a judgment on their proper sphere of action.

E. M.

[**385** (09 (5 + 6)]

LARTILLEUX (H.), former pupil of the Polytechnic, Principal Inspector of the French National Railways. — **Géographie universelle des Transports.** *Tome I* : **Géographie des Chemins de fer français.** *4e Volume :* **France lointaine.** *(Universal Geography of Transport.* Volume I : *Geography of the French Railways.* Part IV : *Overseas France).* — One volume (7 7/8 × 11 3/4 inches) of 232 pages, copiously illustrated, 4 maps. — 1950, Paris, Librairie Chaix, 20, rue Bergère.

In the general schema of the *Universal Geography of Transport,* which is being published by the firm of CHAIX, the first volume is devoted to the French railways. This volume is divided into four parts. As reported in former book reviews in the *Bulletin* (*), the first three parts described the lines of the S. N. C. F., the various railways, and the railways of North Africa. This fourth part the author has devoted to the railways of overseas France.

Even more so than in the previous books, geography is the foundation of the picture, with very diverse colours. In company with the railway, the reader first of all journeys through West and Equatorial Africa, then, in the same Continent, Somaliland and the islands of Madagascar and Reunion. Then he goes on to Indochina, another French colony even larger than the mother country. Finally, transported to various parts of the globe, he visits other colonies in the Indies, the Pacific islands, the West Indies and Guiana.

With a total extent of 23 000 km (14 300 miles), the railways built to assist the economic development of these parts of the French Union have very differing technical characteristics. These depend upon the climate, the contours, the hydrography, the density of population, and the resources to be exploited.

Certain lines have a relatively easy layout; others encountered obstacles necessitating many structures. The most remarkable in this connection is the international line from Yunnan, the Indochinese part of which embraces a whole series of structures unparalleled anywhere else.

Amongst the lines studied, some are

(*) See the *Congress Bulletin,* for the month of January 1950, page 72, and for May 1951, page 322.

equipped for considerable traffic, whilst others are merely lines of penetration.

But whatever their importance and their nature, they are all picturesque. The author gives a detailed description of them. He also narrates the history of their construction, which is often very moving, being full of catastrophes and serious incidents, often extremely dramatic, so that the courage and tenacity of the pioneers were submitted to many a heavy trial.

The illustrations, consisting of maps in black and white and colours, profiles of lines, and various photogravures, are in no way inferior to those of the previous volumes either in attractiveness or abundance.

This fourth book, *Overseas France*, is a worthy finish to Volume I, the *French Railways*, of the « Universal Geography of Transport ». Our readers will certainly await with expectancy the continuation of this important publication which, as we have already explained, will deal in turn with the « Roads », « Air Transport », « Maritime Transport », and finally the « Transport of electricity and Telecommunications ».

E. M.

[656 .25]

TUOT (R.). Ingénieur-Docteur. — **Le problème de la signalisation ferroviaire et sa solution rationnelle.** *(The problem of railway signalling and its rational solution).* — One volume (6 1/4 × 9 3/4 inches) of 126 pages, copiously illustrated. — 1946, Paris, Dunod, éditeur, 92, rue Bonaparte.

In the first section of this work, the author examines critically existing signalling systems in which flexibility has not kept pace with security measures. He then describes an apparatus and explains a working principle by virtue of which it would be possible to ensure reliable and regular traffic operation, without the use of the fixed signals, which are almost universally adopted.

The arrangement consists of an electric generator mounted on each locomotive and supplying current to a circuit of high and constant linear impedance, the circuit being made up of an additional conductor and the track. The voltage of the generator driven of the axle of the locomotive, varies proportionately with the speed of the train. A fixed or movable stop on the track is brought into action by a short circuit.

The power supplied by the « tachymetric » generator on the train which runs at a predetermined speed, increases inversely to the distance which separates it from this stop.

By means of suitably adjusted wattmeter relays, warning and stop signals can then be given to the driver, while the approach of the train can be signalled to the stations concerned and points can be automatically locked.

Substituting track signals for fixed signals by the tachymetric system here described would, in the author's opinion, ensure maximum traffic service by the lines concerned. Leaving out of account the requirements of an actual service, based on the timetables and on the prearranged utilisation of the tracks at stations, he allows the drivers of trains, in view of their relative positions and the speeds of the trains, to control the timing of such trains, so far as this has not already been provided for.

(The specialists in traffic service will attribute the originality of this conception to the fact that the author's activities are not actually concerned with railway working).

In the second part of the book are shown

the methods applied to the system to make it safe in view of particular features of the track and of the special conditions arising with respect to individual movements of the trains themselves.

The power conductor (see above) is provided for by a third rail in the case of steam driven trains, or by a trolley wire in the case of electric traction.

The fixed short-circuit stop (track equipment), the arrangement for announcing and the automatic interlocking are effected by groups of relays installed along the track. Auxiliary direct current supply is provided for.

Protection as between trains is likewise based on the short circuit action. As moreover each train must act on the current-generator of the train ahead of it, rythmical signalling current has been provided.

On each locomotive running on a line occupied by several trains, selection of the appropriate signalling currents would be effected by « bridge selectors » or other suitable measuring instruments of the « bridge » type.

Finally, the author explains a method of continuous control of the tachymetric apparatus, which operates by supplying the necessary current. He does not however indicate the practical steps to be taken in case the system fails, at a time when the fixed track signals might have been abolished.

The book concludes with a survey of the trials which have been carried out in 1938 in the testing laboratories of Messrs Brown Boveri in Switzerland, in order to study experimentally the tachymetric system in operation.

L. D.

[385 (460)]

Red Nacional de los Ferrocarriles Españoles. Desarrollo de su Plan general de Reconstrucción. — *(The Spanish National Railways. — Development of their general reconstruction plan).* — One volume (8 × 10 1/4 inches) of 214 pages, copiously illustrated, maps. — 1951, Madrid, Sucs de Rivadeneyra, S. A., Paseo de Onésimo Redondo, 26.

The Spanish Railways are undergoing a profound transformation at the present time. A vast reconstruction programme, approved in May 1949 by the Government, is now being carried out. Its completion is expected within the next three years.

The chief object of this book is to make known the general outlines of this programme, explain its importance and indicate the results expected.

Already since the liberation, which left the railway in a very sorry state, great efforts have been made to re-establish a satisfactory working. Notable successes had already been achieved both in the case of the fixed installations and stock as well as with the train services. An electrification programme embracing 365 km (230 miles) of lines had also been completed.

However the Management of the R.E.N.F.E. considering that progress was proceeding at too slow a pace, and wishing to modernise the whole system by utilising the technical resources now available, studied a whole series of measures intended to increase the safety and promote efficiency and economy of working. In elaborating its projects, it kept in view the general needs of the country and took its financial resources into account. Such are the guiding principles of the reconstruction programme.

Regarding the methods to be used, which constitute the broad outlines of the programme, the authors first of all give some diagrammatic details. The rest of the book is devoted to the development of each point covered.

The whole equipment of the railway is called upon to benefit from these measures

of renovation. Interesting details are given about the « Reconstruction of the permanent way » in the first chapter. The rolling stock, both trailer and motor, is to be rejuvenated and its maintenance reorganised on new bases. Electrification will be required in the first place to improve the services and result in savings once this new method of traction has been extended to some 1 360 km (845 miles) of lines; its worth has already been appreciated on lines with heavy gradients and tunnels. On the other hand, thank to electrification again, great changes will take place in the signalling, in the signal boxes, in the lines of communication and the lighting system.

The chapter on the working shows all the benefits which both the public and the railway will reap from these new methods and the possibilities of modernised motor and rolling stock.

A few pages are devoted to the way the R.E.N.F.E. is concerned with the material and moral wellbeing of its staff, and to its professional training, together with results obtained.

An important reform has been made in the statistical work by the introduction of the perforated card machine system. In addition to statistics on the mileage and traffic, these are used to calculate the staff bonuses which have been found to be very profitable.

Whilst endeavouring by the modernization of the system to improve the services offered and satisfy the ever growing needs of the national economy, the Management of the R.E.N.F.E. has not lost sight of the financial aspect of the projected reforms and those already being realised. On a conservative estimate, these should result in very considerable savings. The results already obtained make it possible to affirm that the Spanish Railways in the very near future should achieve economic stability and financial independence.

This book, which has been carefully edited, and is abundantly illustrated and full of very useful graphical documentation, contains much matter of the greatest interest. It bears witness to the desire of the Management of the R.E.N.F.E. to place a completely modernised railway system at the disposal of the country, within the very near future.

E. M.

[656 .1 (45) & 656 .2 (45)]

Strada e Rotaie. La realta della situazione secondo le statistiche del Ministero dei Trasporti. (**Road and Rail.** *The true situation according to the statistics of the Ministry of Transport.)* — One volume (6 1 4 — 9 3 4 inches) of 44 pages and 21figures. — 1951, Published by F. E. N. I. T. (National Federation of Transport Undertakings), Roma, Via 5. Martino della Battaglia 4.

This brochure is a decisive answer to the thesis advanced in certain quarters that the railway is technically and economically outdated and should be liquidated in favour of other methods of transport.

The arguments are taken from the statistics of the Ministry of Transport in Italy for the year 1947. The comparison is limited to passenger traffic and covers the rural omnibus, tramway and railway services.

The data selected by the authors are given in the form of figures and also graphically. They are accompanied by a brief commentary stressing their significance.

We will leave it to the reader to consider these comparative data and profit thereby. We will merely mention the fact that the omnibus services are characterised by the relatively limited extent of their routes, the small number of passengers carried, and

the higher cost per passenger kilometre. On the other hand the rates are much higher.

The railway is the organisation which employs the largest staff, almost as numerous as that of the omnibus and tramway services combined. The cost of staff amounts to 64.03 % of the operating costs on the railway, 74.02 % on the tramways and 20.63 % only on the omnibus services.

One comment not without value is the great vulnerability of the omnibus services to political events and economic stresses.

The year 1947 was a good year for the omnibus services which were able to develop freely whilst the railway was still in the throes of reconstruction. This circumstance is invoked to strengthen the argument which serves as a basis for this short but substantial study.

E. M.

[6]

Répertoire des Organisations Scientifiques Internationales. *(List of International Scientific Organisations.)* — 1950, Paris. Published by the *United Nations Organisation for education, science and culture (UNESCO).*

This publication is the result of a desire to create an annual giving the chief data concerning the international scientific organisations. *UNESCO* undertook the work as a result of a resolution formulated at the third session of the General Conference held in Beyrouth in 1948.

The necessary data were collected by means of a questionnaire sent to the organisations concerned. For various reasons certain gaps were unavoidable. The Scientific Department of *Unesco* will be glad to receive any information which readers can supply for a future edition.

This list covers international organisations whose activities are devoted to questions of a scientific nature. They have been grouped into three main chapters, called respectively : « Fundamental science, applied science, and various ». The second chapter is subdivided into « Agricultural science, engineering science, and medical science ». In the chapters and sub-chapters, the organisations are listed alphabetically.

The data given about the various organisations are fairly detailed. They come under sixteen different headings. Without mentioning all of these, apart from those dealing with their constitution and organisation, they relate to their periodical meetings and publications.

The organisations listed are very numerous. In the sub-chapter entitled : « Engineering science », there are 24, amongst them the « International Railway Congress Association ».

Intended for specialists, this list, it is to be hoped, will be found very useful by them in carrying out their work.

E. M.

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PUBLISHED UNDER THE SUPERVISION OF

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1951 **621** .33 (44)
Notre Métier, 5 novembre, p. 2.
Les **économies procurées par l'électrification** de la section Paris-Dijon en 1950. (800 mots.)

1951 **621** .33 (44)
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Un aperçu des journées d'information sur la **traction électrique par courant monophasé de fréquence industrielle.** (1 500 mots.)

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1951 **625** .28 (44)
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MERMIER. — La **zone de traction moderne** du Languedoc. (5 000 mots & fig.)

1951 **656** .212 .6 (44)
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DELACARTE & SCHEER. — Une **modernisation économique des grues des gares** sur la Région du Sud-Est de la S.N.C.F. (1 300 mots & fig.)

1951 **625** .234
Revue générale des Chemins de fer, octobre, p. 480.
GIRARD & MORON. — Nouvelles recherches expérimentales sur l'**isolation thermique des voitures** de chemins de fer. (6 000 mots & fig.)

1951 **625** .2 (0
Revue générale des Chemins de fer, octobre, p. 495.
GASPARD. — La **résistance du matériel roulant aux efforts mécaniques** *(suite)*. Essais statiques, sous charges verticales, de deux nouveaux wagons à déchargement bilatéral pour transport de minerai. (1 000 mots & fig.)

1951 **385** (09 (73)
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Une **mission ferroviaire européenne aux Etats-Unis** en 1950. (4 000 mots.)

1951 **621** .33 (44)
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Le **projet d'électrification** de la ligne de Valenciennes-Thionville. (1 000 mots & fig.)

1951 **625** .42 (460)
Revue générale des Chemins de fer, octobre, p. 509.
PLANELL (F.). — Le prolongement du **Chemin de fer métropolitain** transversal de Barcelone. (1 200 mots & fig.)

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1951 **625** .213
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LIGIER (A. G.). — Contribution à l'étude de la **suspension des véhicules. Problèmes des ressorts à lames.** (2 500 mots & fig.)

1951 **621** .431 .72 (44)
Revue générale de Mécanique, juillet, p. 213.
OLIVE. — Emploi de **segments chromés** dans les moteurs Diesel de la S.N.C.F. (500 mots & tableau.)

1951 **621** .9 (06
Revue générale de Mécanique, août, p. 231.
L'**Exposition Européenne de la Machine-Outil.** (Numéro consacré entièrement à cette exposition). (80 pages et illustrations.)

1951 669
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HEDDE D'ENTREMONT (B.). — Les **traitements thermiques** à l'atelier. (6 000 mots & fig.)

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1951 **621** .438
Science et Vie, mai, p. 291.
DEVAUX (P.). — La **turbine à gaz** révolutionne la mécanique. (3 000 mots & fig.)

1951 **625** .173
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Par tronçons de 200 m, un rail posé tel un ruban. (600 mots & fig.)

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1951 **621** .9 (06
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Le matériel présenté à l'Exposition Européenne de la Machine-Outil. (25 000 mots & fig.)

1951 **656** .212 .6 (44)
La Technique Moderne, septembre, p. 421.
ROUSSE (R.). — **Problèmes de manutention mécanique** à la S. N.C.F. **Unification des matériels.** (5 000 mots & fig.)

1951 **625** .28 (44)
La Technique Moderne, septembre, p. 445.
Le **matériel S.N.C.F.** exposé aux Invalides en juin 1950. (1 500 mots & fig.)

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BÜHLER (H.). — **Tensions internes créées par le travail mécanique à froid.** Les moyens de les réduire. (1 600 mots & fig.)

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1951 **625** .1 (493)
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WEBER (R.). — Aperçu des **aménagements et perspectives d'exploitation de la jonction Nord-Midi.** (10 000 mots & fig.)

1951 **621** .138 .5 (493) & **625** .26 (493)
Trains, nº 2, juin, p. 27.
LENFANT (H.). — La **reconstruction de l'Atelier Central de Malines.** (2 000 mots & fig.)

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1951 **625** .13 (44)
Travaux, mai, p. 347; juin, p. 383.
ESQUILLAN (N.). — La **reconstruction du viaduc de la Méditerranée** sur le Rhône entre Givors et Chasse. (18 000 mots & fig.)

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BARETS (J.), HERVET (J.) & AVERSENG (E.).— **L'évolution de la précontrainte.** Enseignements déduits de la construction de divers ouvrages. Pont d'Arles-en-Tech. (6 000 mots & fig.)

1951 **624** .63 (44)
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1951 **625** .113
Der Eisenbahnbau, Mai, S. 105; Juni, S. 141.
SCHRAMM (G.). — **Gegenbogen** bei Gleisverziehungen und Weichenverbindungen. (7 000 Wörter & Abb.)

1951 **725** .31 (43)
Der Eisenbahnbau, Mai, S. 110.
BANGEN (W.). — Der **Wiederaufbau des Empfangsgebäudes** Bochum Hbf. (2 000 Wörter & Abb.)

1951 **621** .392 (43) & **625** .151 (43)
Der Eisenbahnbau, Mai, S. 114.
DERLIN (K.). — **Verschweissen von Weichenbezirken** in durchgehenden Hauptgleisen. (3 000 Wörter & Abb.)

1951 **625** .172
Der Eisenbahnbau, Mai, S. 119.
AMBERGER (E.). — **Berichtigung der Gleisfestpunkte.** (2 000 Wörter & Abb.)

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ROTHMEISTER (G.). — Der **Oberbau im Anschluss an offene stählerne Brücken.** (1 500 Wörter & Abb.)

1951 **625** .113
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HÖFER (M.). — **Die nachträgliche Verbesserung der Übergangsbogen zwischen Korbbogenteilen im Nalenz-Verfahren.** (2 000 Wörter & Abb.)

1951 **625** .143 .5
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WENTZEL (R.). — **Schienenbefestigung.** (5 000 Wörter & Abb.)

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PASQUAY (R.). — Gedanken zur **Befestigung schienengleicher Wegübergänge für schweren Strassenverkehr.** (1 200 Wörter & Abb.)

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WARNICK (A.). — **Zulässige Pfeilhöhenfehler bei Gleisbogen.** (4 000 Wörter & Abb.)

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ROTHFUCHS (G.). — Die **Tragfähigkeit von Mauerwerk** aus klein- und grossformatigen Steinen. (4 500 Wörter, 7 Tafeln & Abb.)

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BRUST (G.). — **Warum nicht Stahlbeton für Eisenbahnbrücken** ? (1 500 Wörter.)

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GOTHE (F.). — **Befestigung der Wegübergänge.** (1 000 Wörter & Abb.)

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1951 **625** .14 (01 & **625** .2 (01
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HEUMANN. — Grundlagen und leitende Gesichtspunkte zur **Erzielung ruhigen Laufs von Eisenbahnfahrzeugen.** (7 000 Wörter & Abb.)

1951 **625** .215
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MIELICH. — Konstruktive Möglichkeiten zur Erzielung eines **ruhigen Wagenlaufes von Eisenbahnfahrzeugen.** (3 500 Wörter & Abb.)

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TASCHINGER. — Der gegenwärtige Stand in der **Untersuchung des Geräuschproblems von fahrenden Eisenbahnwagen.** (15 000 Wörter & Abb.)

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FINK (M.). — Einige Anmerkungen zu den **luftbereiften Michelin-Expresszugwagen.** (3 000 Wörter & Abb.)

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1951 **385** (06 (4)
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DOPKE (W.). — **internationale Stützen des europäischen Eisenbahnverkehrs.** (500 Wörter & Tafel.)

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v LOCHOW (H. J.). — **Sechzig Jahre Eisenbahn in der Mandschurei.** Historische Studie unter Berücksichtigung der sowjetisch-chinesischen Staatsverträge von 1945 und 1950. (4 000 Wörter & Karten.)

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MÜLLER (W.) .— Die **Selbstkosten der Verkehrsbetriebe auf Schiene und Strasse** im Wettbewerbszeitalter. (6 000 Wörter.)

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1951 **385** (09. 3 (494)
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NOCK (O. S.). — **Western Region gas turbine locomotive** in service. (2 000 words & fig.)

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TRIPP (G. W.). — Motor vessel « Norfolk Ferry ». (2 200 words & fig.)

1951 **621** .431 .72 (59)
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Diesel-electric locomotives for Ceylon. (1 600 words & fig.)

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The Engineer, August 24, p. 249.
4-6-4 locomotives for the Victorian Railways. (2 000 words & fig.)

1951 **656** .211 .7 (42 + 44)
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TRIPP (G. W.). — French Railways' **train-ferry** M.V. « Saint Germain ». (1 900 words & fig.)

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GRANHOLM (H. J.). — Modern **developments in reinforced concrete design.** (5 000 words, fig. & one table.)

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1951 **625** .236 (42)
Engineering, June 15, p. 738.
Washing plans for railway vehicles. (400 words & fig.)

1951 **621** .132 .1 (42)
Engineering, June 22, p. 752.
Mixed traffic 4-6-0 locomotives, British Railways. (1 800 words & fig.)

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JENDRASSIK (G.). — **Diesel engines for traction purposes** *(to be continued).* (6 000 words & fig.)

1951 **621** .33 (42) & **625** .13 (42)
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Progress with new Woodhead tunnel. (1 500 words & fig.)

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The Locomotive, November 15, p. 166.
Main line Diesel-electric locos, South Australian Government Railways. (1 000 words & fig.)

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500 HP Diesel-mechanical locomotives. (1 200 words & fig.)

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New bulk discharge containers for British Railways. (200 words & fig.)

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Underground Railways abroad. — New role of Paris Metropolitain Company. (1 200 words & 2 maps.)

1951 **621** .431 .72 (41)
Modern Transport, September 8, p. 3.
Operation of Diesel railcars in Ireland. (800 words & fig.)

1951 **656** .224 (42)
Modern Transport, September 15, p. 9.
More **buffets on trains,** replacing little-used restaurant cars. (1 200 words & fig.)

1951 **621** .139 (42)
Modern Transport, September 15, p. 15.
Savings in railway storekeeping. (1 000 words & fig.)

1951 **385** (09 (6)
Modern Transport, September 29, p. 5.
East African Transport. **Traffic increases and port improvements.** (1 500 words & fig.)

1951 **621** .431 .72 (942)
Modern Transport, September 29, p. 13.
South Australian Railways. — First **main-line Diesel-electric.** (400 words & fig.)

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Locomotives for Peru. — Hunslet 500 HP **Diesel-mechanical units.** (300 words & fig.)

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Jamaica's new rolling stock. (2 000 words & fig.)

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Eight pressure-charged locos. for Ceylon. (1 200 words & fig.)

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Railcars in sparsely populated Donegal. (1 000 words & fig.)

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How to minimize damage from **crankcase explosions.** (2 900 words & fig.)

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QUINN (W. J. G.). — What about the **passenger deficit?** (2 200 words & fig.)

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Tie-renewal decline stopped in 1950. (2 000 words, tables & fig.)

1951 **625** .17 (73)
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How the D. L. & W. gets **results from annual programming of maintenance work.** (3 000 words & fig.)

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PARMELEE (Dr. J. H.). — **How fixed charges have been cut.** (1 400 words, tables & one graph.)

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HENSHAW (M. D.). — Package controls for **Diesel-electric locomotives.** (3 000 words & fig.)

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Do public relations and advertising go together ? Question answered by Union Pacific. (3 200 words, tables & fig.)

1951 **656** .254 (73)
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Atlantic Coast Line works to eliminate **grade crossing accidents.** (1 500 words & fig.)

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KUSIK (J. E.). —**How the « Financial Man » can help management.** (5 000 words, fig. & two graphs.)

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MacDONALD (R.). — Graph provides visual record of **curve alinement.** (700 words & one graph.)

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A new design of locomotive wheel centre. (500 words & fig.)

1951 **62** (01 & **624** (0
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Testing a 40-ft. pre-stressed concrete bridge span. (1 500 words & fig.)

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Announcing train arrivals at Euston. (1 200 words & fig.)

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POULTNEY (E. C.). — **Advantages of top feed delivery.** (3 000 words & fig.)

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Integration of transport. Difficulties encountered, and the problem of competition with nationalised undertakings. (2 000 words.)

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1951 **656** .281 (42)
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Electric locomotive performance in Switzerland. Working results and maintenance costs on the Berne-Lötschberg-Simplon Railway. (600 words.)

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KOFFMAN (J. L.). — **Fans for traction applications.** (6 900 words, tables & fig.)

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French Diesel-mechanical shunters. (1 000 words & fig.)

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New power signalling at York. (1 600 words & fig.)

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KIRKBY (N. O.). — **Controls for heating and air conditioning.** (2 400 words & fig.)

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A flat car with 500 000 lb. capacity. (600 words & fig.)

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BINDA (P. A.). — **Engine oil pressure.** (8 000 words & fig.)

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PRIEST (H. M.). — **Rust.** — How to combat it by proper design. (6 000 words & fig.)

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I. C. tests device to reduce **hot boxes.** (2 600 words & fig.)

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YELLOTT (J. I.), BROADLEY (P. R.) & BUCKLEY (F. D.). — **Tests of coal-burning gas turbine under way.** (4 000 words & fig.)

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WALLACE (W. K.). — **Steel rails.** (3 600 words & fig.)

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BARRES (F.). — **Transportes en la ciudad y gran Buenos Aires.** (4 000 palabras, mapas y cuadros.)

1951 621 .431 .72 (73)
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Hormigón elastico. (Buenos Aires.)

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PISTOR (L.). — **Calculo de secciones de hormigón precomprimido.** (3 000 palabras & fig.)

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BILLIG (K.). — **Hormigón con solicitación previa de tracción.** (5 000 palabras & fig.)

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NURSE (R. W.). — **Curado del hormigón mediante vapor.** (6 000 palabras & fig.)

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CERADINI (G.). — Esperienze su recenti **ponti italiani di cemento armato.** (7 000 parole & fig.)

1951 624 .2 & 691
Giornale del Genio Civile, luglio-agosto, p. 498.
RINALDI (G.). — **Prove sperimentali a fessurazione e rottura su una trave isostatica rettilinea in cemento armato** prefabbricata precompressa di metri 50 di luce. (2 000 parole & fig.)

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LEVI (F.). — Su alcune singolàrita del **comportamento statico del conglomerato cementizio.** (8 000 parole & fig.)

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1951 621 .133 .3
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PISTONE (G.). — Analisi del **comportamento termico delle caldaie tipo Crosti** per locomotive. (3 000 parole & fig.)

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BOGANELLI (E.). — **Correlazione fra attitudini psicofisiologiche ed infortuni.** (4 000 parole & fig.)

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Il IV Congresso Italiano dei Trasporti ha avuto per tema centrale la **determinazione del « costo »**, fattore essenziale nel problema del coordinamento. (20 000 parole & fig.)

In Netherlands.

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VAN DORSSER KEUS (J. A.). — **Een en ander over C. T. C.** (4 000 woorden & fig.)

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De **koninklijke Egyptische trein.** (1 000 woorden & fig.)

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KOSTER (J. P.). — **Electrische tractie met eenphase wisselstroom 50 perioden.** (5 000 woorden & fig.)

1951 **656** .21

Spoor- en Tramwegen, 1 November, p. 363.

Wat moet er op een groot station worden verricht alvorens een nieuwe dienstregeling marcheert ? (2 000 woorden & fig.)

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DE PATER (A. D.). — Enige recente merkwaardigheden op het gebied van de **stoomtractie** in Amerika. (1 000 woorden.)

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MACHADO VAZ (J.A.). — **Electrificaçáo ferroviária.** (5 000 palavras & fig.)

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TIROA (J.). — Notas sobre a **resolução de sistemas hiperstáticos pelo método de Rieger.** (1 500 palavras & fig.)

1951 **691** (469)

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